PLASTER OF PARIS TECHNIQUE

IN THE TREATMENT OF FRACTURES AND OTHER INJURIES



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IN THE TREATMENT OF FRACTURES AND OTHER INJURIES

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1946

THE MACMILLAN COMPANY · NEW YORK

Set up and electrotyped. Published 1945.

Reprinted June 1946

SET UP AND ELECTROTYPED BY BROWN BROTHERS LINOTYPERS
PRINTED IN THE UNITED STATES OF AMERICA

INTRODUCTION

The construction of plaster casts has been called an art, but is rather a craft since it can be learned by anyone of reasonable intelligence with a modicum of manual dexterity. The plaster cast is the best splint in the armamentarium of the surgeon. It is cheap, durable, and when properly fashioned exactly fits the individual patient under conditions imposed by his particular injury.

While the modern literature of trauma leaves almost no question of principle or choice of method of treatment unanswered, little has been written concerning the exact technique of the application of plaster casts. The following pages are not concerned with the diagnosis, evaluation, pathology, or prognosis of trauma. Only the mechanical application of one method of treatment is considered and only brief mention of the common indications for each cast is made.

No two injuries are ever quite the same and the varieties of casts that may be required for particular situations are infinite. However, the majority of casts used in ordinary practice are included in the following descriptions. The techniques presented have stood the test of usage by the author and his colleagues. Simplicity is emphasized. While a "fracture table" is a great asset, it is not always available and the surgeon should not become too dependent on complex mechanical assistance.

Many of the procedures in the construction of casts recommended in the following pages on the basis of clinical experience, have been confirmed from an experimental point of view by the careful original researches of Luck,[1] whose paper should be read by all surgeons doing more than occasional Plaster of Paris work.

It is hoped that this book will be useful to students, house officers, and particularly to those members of the profession who assume responsibility for the management of trauma and train others in the techniques involved.

[1] Luck, J. V., "Plaster of Paris Casts, An Experimental and Clinical Analysis", *Journal of the American Medical Association;* January, 1944, 124, pp 23–29.

CONTENTS

LIST OF ILLUSTRATIONS

CHAPTER I

GENERAL CONSIDERATIONS

MATERIALS

Plaster of Paris ($2\ CaSO_4, H_2O$) is prepared by calcining gypsum ($CaSO_4, 2H_2O$) at a temperature between 100° and 200° C. until ¾ of its water is lost. When the water is replaced, the reconstituted dihydrate expands very slightly as it crystallizes in the form of needles, the interdigitation of which produces a firm absorbent white mineral. This "setting" normally requires about 20 to 25 minutes for pure Plaster of Paris. Drying requires from 24 to 72 hours, depending on climatic conditions. Setting can be accelerated by adding salt or other substances to the water or dry plaster. "Fast" dental plaster sets in about 10 minutes and meets most surgical requirements.

In the construction of splints and casts, Plaster of Paris is always used with a cloth reinforcement of which the best is crinoline or bookbinder's muslin, 24-mesh, unsized, or sized with starch rather than with glue. A few surgeons, following the example of the French school, construct casts from patterns or *attelles* cut from several thicknesses of crinoline dipped into plaster cream just before application. This method produces excellent casts which can be applied very rapidly but requires more than the ordinary amount of skill and teamwork. The commonest method, which is described in this book, employs roller bandages impregnated with plaster. These can be made or purchased ready-made. The preparation of Plaster of Paris bandages is not easy. Five-yard strips of crinoline are slowly passed across a table while dry plaster is thoroughly rubbed into the meshes, either by hand or with a wooden paddle (Fig. 1). The bandages are loosely rolled, individually wrapped in waxed paper, and stored in large tins until used. Such homemade bandages, if not hemmed, very often ravel during application and are subject to con-

siderable unpredictable variations in quality. For these reasons machine-made bandages, although somewhat more expensive, are preferable. There are two types on the market—"fixed" and "loose."

"Fixed" plaster bandage is made by passing the hemmed crinoline through either a mixture of powdered gypsum, an adhesive substance and a volatile nonaqueous solvent, and allowing it to dry, or an aqueous plaster cream and recalcining. The plaster then becomes an integral part of the bandage, with no tendency to fall through the meshes. Such bandages produce beautiful casts of great strength,

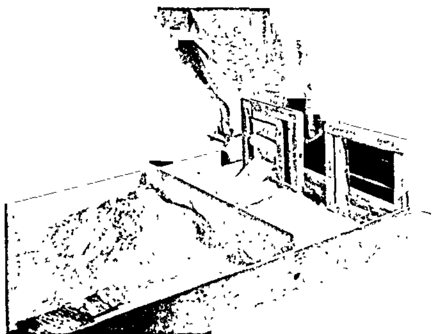


Fig. 1. A table arranged for rolling "homemade" plaster bandages.

lightness, and rigidity, but are not generally used in the United States and require somewhat more than average skill in application.

"Loose" plaster bandage is similar to homemade except that the edges do not ravel, the plaster is evenly distributed in the meshes of the cloth, and the quality does not vary. It is this type, setting in about ten minutes, which is most generally used and on which the techniques described in this book are based. All plaster casts described in the following pages can be made from two widths of plaster bandage—3-inch and 6-inch. If odd widths are required, the dry

rolled bandage is most easily cut with a bread knife with a serrated edge. A standard 6-inch roll of machine-made "loose" plaster bandage weighs approximately 315 grams before use, 530 grams when set, and 275 grams when quite dry.

Machine-made plaster bandages, sold by reputable firms, can be considered to be sterile when packaged and to contain no substance which might serve as a culture medium for bacteria.

Whatever type of plaster bandage is used, it must be stored in as dry a place as possible, and containers should be kept covered.

In addition to plaster bandage, the following basic materials will be required:

(1) *Stockinette.* Three sizes should be at hand, 3-inch for the arm and lower leg, 6-inch for the thigh, and 9-inch for the trunk. It can conveniently be stored in reels fastened to the wall of the operating or plaster room.

(2) *Sheet Wadding.* This can either be purchased or made up from bolts into bandages 6 inches wide and 5 yards long. It should be uniform in quality, not more than ¼ inch in thickness, free from lumps, and fragile enough to tear easily.

(3) *Felt.* Only the softest felt should be used. The quality should be uniform, and it should split easily. The greatest thickness ever necessary is ½ inch and ¼ inch is most commonly used. It can be stored in strips 10 x 36 x ½ inches which should be autoclaved. Felt is an animal product and may harbor bacterial spores.

(4) *Reinforcing Rods.* Lengths of ¼-inch rods of the type used in reinforcing concrete are necessary for the support of many types of casts. Long curves can easily be made with the hands in this size of rod. For sharp curves or angles, two monkey wrenches or bending irons are required. A hacksaw is, of course, necessary for cutting the rods.

(5) *Wire.* Twelve- or 14-gauge iron wire is the most useful size for "banjo" splints and the reinforcement of small casts.

(6) *Knives.* Two types are necessary. The largest sized scalpel, with removable blades, is useful for cutting and trimming wet plaster. Blades which have been discarded from the operating room are sharp enough for the purpose. Several plaster knives should be at hand. The best type has a handle 3½ inches in length and a curved

blade 1½ inches in length, with the edge on the concavity. The blade should be anchored to the handle throughout its length and should be thick enough to permit a certain amount of prying without breaking. The knives used by grape and other fruit growers fill all these requirements and are cheap. Plaster knives should be sharpened almost every time they are used.

(7) *Scissors.* Two pairs of large, heavy, sharp bandage scissors are essential. During the actual application and molding of plaster, scissors are constantly in use by the surgeon and his assistants and have a way of getting mislaid under drapes or in buckets when most needed. Some surgeons tie a pair to a cord around the waist or neck.

(8) *Cast Cutters.* The Stille model is the best, and only the largest size is necessary.

(9) *Tape Measure.* Slabs should be measured exactly. Too short a slab may weaken the whole cast; too long a one may produce sloppy ends or, at best, lost time in trimming.

(10) *Needle and Thread.* Sewing is often the best method of uniting segments of stockinette or of holding felt in place.

(11) *Rubber Tube.* A piece of soft, elastic rubber tube, ½ inch in diameter and 40 inches in length, well greased with vaseline, is used to facilitate later cutting and bivalving of large casts (Figs. 2 and 68).

(12) *Buckets.* Two buckets should be at hand, as two sources of wet plaster bandages often results in less confusion in the construction of large casts. Old plaster should not be allowed to accumulate in the bottom of buckets. Cleaning can be facilitated by lightly greasing the inside with vaseline just before use.

(13) *A Smooth Surface* While plaster slabs can be made on the floor, a table top, or better still, a drainboard of metal, tile, or glass is a great help. It should be at least 4½ feet long and 2 feet wide and should tilt slightly toward a sink. The sink should be deep enough to accommodate a bucket, and the hot and cold water should have a common outlet. The drain should have a large and easily accessible trap.

(14) *Gloves.* Rubber gloves which have served their time in the operating room are perfectly satisfactory for plaster work. If these are not available, the hands can be covered with cold cream.

(15). *Clothing.* Gowns or aprons should be worn by all members of the plaster team. Some sort of foot covering is especially important. Shoes, slippers, or overshoes worn in the plaster room should be changed at the door and not worn elsewhere. White footprints leading from the plaster room to other parts of the hospital reveal a lack of consideration for those whose duty it is to keep the floors clean. No attempt should be made to remove plaster from clothing until it is quite dry, when it can easily be brushed off.

Other materials, including rope, pulleys, tape, slings, and rests are required for the positioning of limbs for certain casts. These are described under the appropriate headings on the following pages.

ORGANIZATION

When a cast is to be applied, all the materials required should be at hand; everyone concerned should clearly understand exactly what is to be done and the steps involved. The surgeon should explain in advance to his assistants just what he expects each to do. The construction of a cast, except for the very simplest, is a matter of teamwork, and nothing can be more disastrous to a healing fracture or compound wound than the fumbling of a well-meaning, but ill-informed assistant.

FIXATION BEFORE THE APPLICATION OF PLASTER

Whenever possible, the part to be encased in plaster or splinted should be supported in the desired position by slings from the table, wall, or overhead beams. When held by an assistant, there is always a certain amount of motion, while the plaster is setting at joints and at the sites of fracture, which results in buckling, weakness of the cast, and possible points of pressure against the underlying tissues. Fixation is very easily achieved on any of the standard fracture or orthopedic tables, but can be accomplished with little more special equipment than is found in the average household, plus a moderate amount of ingenuity (Fig. 2).

Satisfactory position can be maintained for application of any of the casts described in the following pages with no more com-

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tical. The ideal cast has no other padding than stockinette, but it must be fashioned with the greatest care in molding over bony prominences, avoiding even the smallest folds, wrinkles, and dents. The ability to apply such a cast comes only with practice, and until the surgeon is quite confident of his skill he should follow the axiom: *When in doubt, pad!* A pressure ulcer over a bony prominence can easily produce deformity and disability lasting much longer than the original injury for which the cast was applied.

Frequently the circumstances of the operation, manipulation, or reduction, are such that stockinette cannot be slipped over the limb. Two layers of sheet wadding are then used instead, applied as a circular bandage, with great care to avoid folds, creases, and overlaps, and stockinette or flannel bandage is fitted at each end of the projected cast to serve as a cuff to turn back over the rough ends of the plaster.

Dressings should be held in place by stockinette or sheet wadding. Adhesive tape should never be applied to the skin under a plaster cast. Some degree of skin infection is sure to occur in time, and approximately 5 per cent of patients are more or less allergic to adhesive tape.

Soft felt, ¼ inch thick, is adequate protection for most bony prominences. Pads should not be longer than necessary, should be tailored to fit by slitting or by the excision of wedges, should be beveled at the edges, and should never overlap. Felt can be held in place on stockinette by a few stitches or bits of adhesive tape. When stockinette is not used, the pads are held by turns of sheet wadding. No circular bandage other than sheet wadding should ever be used under Plaster of Paris.

THE APPLICATION OF PLASTER

When the wound has been treated, the fracture reduced, or the manipulation completed, the limb padded and fixed in position, and the greased rubber tube laid in place, the application of plaster can begin.

All plaster casts described in the following pages are built by laying a series of slabs on the surfaces of the limb to be splinted and

plicated equipment than kitchen tables, broomsticks, boards from packing cases, clothesline, and flannel bandage.

PADDING

In recent years there has been considerable discussion about the virtues and shortcomings of the unpadded plaster cast. Certainly



Fig. 2. A leg fixed in position for application of a full-leg cylinder for a healing fracture of the tibia and fibula. Stockinette and felt padding are in place. Note greased rubber tube, which will be removed when plaster has set.

too much padding results in inadequate immobilization, but too little may produce pressure, sores, nerve injury, or even gangrene. The ideal lies somewhere between. All casts should have one layer of stockinette between the skin and the plaster. Those who hold that plaster should be applied directly to the skin, incorporating the hairs, have never had such a cast removed a few days after application. The skin over most parts of the body moves quite freely over the underlying fascia, and the argument that fixation of hair in the plaster will better immobilize the deep tissues is more theoretical than prac-

uniting them with circular turns of plaster bandage. The exact dimensions of all slabs should be determined with a tape measure as soon as the limb is fixed in position and marked on the table top or drainboard. Two plaster bandages are placed on end in a bucket of lukewarm water. As soon as bubbling has ceased, one is gently removed and its end lightly squeezed to remove excess water (Fig. 3). Plaster bandages should never be "wrung out" (Fig. 4) but should be used "sloppy wet." The bandage is then rapidly rolled out

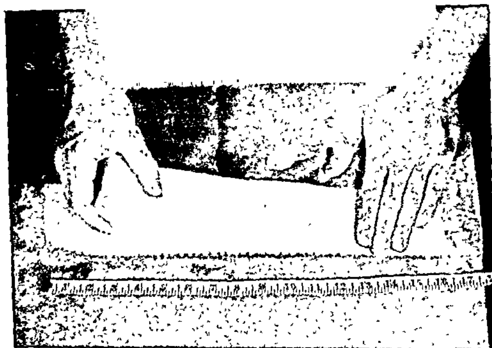


Fig. 5. Making a plaster slab.

on the table top to the length of the desired slab and back and forth upon itself until 6 or 8 thicknesses have been laid upon each other (Fig. 5). Thicker slabs are unwieldy and do not mold easily. If greater strength is required, two or more 6- or 8-layer slabs should be used. As the slab is being rolled out, care should be exercised to avoid longitudinal wrinkles, and, as each layer is laid on, it should be gently rubbed to drive out air bubbles. Vigorous or heavy rubbing will drive out water as well and make the slab stiff. Dry slabs are best constructed with "fixed" plaster bandage. If "loose" bandage is used, much of the Plaster of Paris falls through the meshes of the



Fig. 3. Correct method of squeezing excess water from a plaster bandage. The ends of the bandage roll are lightly compressed.

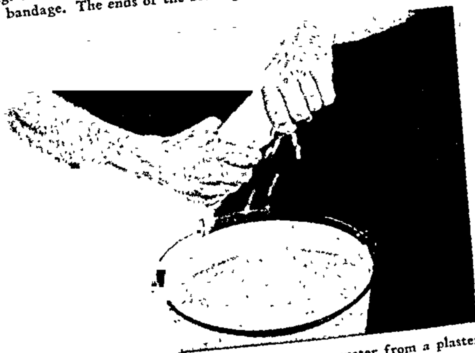


Fig. 4. Incorrect method of removing excess water from a plaster bandage. The bandage will be dry, stiff, and unwieldy.



Fig. 6. Method of holding plaster bandage during application. A tuck is being taken over a slab.



Fig. 7. Removal of a sling and pad after slabs have set. The gap will be closed by a few turns of plaster bandage.

crinoline and is lost. Each time a wet plaster bandage is removed from the bucket it is replaced by a dry one. There should never be more than two or three bandages in the water at one time. Water should be changed from time to time in the construction of large casts. Bandages soaked in water saturated with plaster tend to become lumpy and granular. After the slab or slabs have been laid on and molded to the limb, they are anchored in place by circular turns of plaster bandage. This is, at the same time, the most difficult and the most important step in the fashioning of a plaster cast. The bandage should be wet, but not dripping. It is held lightly in the palm so that, as it is applied, it unrolls from the thumb around to the fingers (Fig. 6). Wrapping should be done smoothly, rapidly, with constant rubbing and *without tension*. Plaster bandage is *laid* and *not pulled* into place. From time to time in wrapping it will be necessary to take tucks in the bandage. These should be so taken that they lie over the slabs, and that the folds do not form irregularities on the inner surface of the cast (Fig. 6). Iron rod reinforcements are bent to exact shape, laid lightly on the slabs, and held in place by circular turns. They should never be pressed into the slabs. Circular turns are not taken over, or across, supporting slings. After the slabs and the main parts of the cast have set, the slings are slipped out, together with their padding, and the gaps closed with a few circular turns (Fig. 7). The greased rubber tube, if used, is removed, and the excess stockinette turned back over the ends of the cast and held with one or two final turns of plaster bandage. Vigorous or prolonged rubbing at this point, when the plaster is setting, is inadvisable. The interdigitation of the monoclinic crystals of hydrated calcium sulfate can easily be disturbed and the strength of the cast as a whole impaired. A smooth finish can be achieved by making a small quantity of plaster cream from loose plaster in a small bowl, rubbing this thoroughly over the cast, dusting it heavily with talc just as it sets, and polishing briskly with a soft towel or piece of flannel. The final step is marking. With an indelible pencil the position of the channel made by the greased rubber tube is indicated, an outline is made of the fracture or other injury over its site, and the dates of injury, operation, tetanus antitoxin administration, and application of plaster are listed (Fig. 8). These data are often very helpful in civil practice,

CARE AFTER APPLICATION OF THE CAST

When the patient with a plaster cast returns to his ward or home, ie surgeon is obliged to delegate his judgment at a critical time. . number of serious complications can occur in a relatively brief eriod, all of which are the result of tissue ischemia. If edema occurs



Fig. 9. A pressure ulcer from localized ischemia.

within a rigid cylindrical plaster cast, first the veins and then the arteries are obstructed, and, unless the pressure is promptly relieved, irreversible damage may be done. Localized pressure from dents or irregularities on the inner surface of the cast or from careless molding over bony prominences can cause skin and nerve necrosis from

when records may be mislaid, and are essential in military practice since records may be lost altogether.

Some surgeons apply a coat of shellac or lacquer after the cast has dried for a few days. This may be advisable for small casts which might be exposed to moisture, but it should be remembered that the porosity of Plaster of Paris is one of its most valuable qualities, and sealing with paint may result in maceration of the underlying skin.[1]



Fig. 8. The completed marked cast.

The completed cast should be neat and tidy in appearance. Like a skin incision it is the most obvious and visible result of the surgeon's labors and only too often is taken as the sole criterion of his judgment and skill. A well-planned and carefully executed reduction or operation may be concealed beneath a sloppy and ragged cast, or a neat and polished plaster may cover ill-advised and careless surgery, although the chances are against it.

[1] This might be a case against the use of plastics in the making of casts. Since plastics are non-porous, there is the danger of maceration of the underlying skin.

localized pressure may be fleeting. Ulcers can develop rapidly, especially in the aged and malnourished, and become painless in a few hours after the sensory nerve endings have been destroyed, only to be revealed weeks later when the cast is removed.

Numbness. The first indication of ischemia, or pressure on a peripheral nerve, may be tingling followed by numbness in the limb. It must always be explained and relieved, usually by splitting or bivalving the cast. In some instances, such as injuries about the elbow, the position of the extremity, rather than the cast itself, may be at fault, and the surgeon is faced with the dilemma of abandoning the position and risking future deformity or maintaining the position and jeopardizing the blood supply to the limb. The decision is not, as a rule, difficult. A deformed limb which is intact is far preferable to a symmetrical limb with paralysis, Volkmann's contracture, or gangrene.

Cyanosis. The color of the extremity at the distal end of the cast should be the same as that of the uninjured limb when placed in the same position. Slight duskiness alone is not an indication for immediate action but calls for increased vigilance. If the color deepens, and other signs and symptoms appear, immediate investigation and treatment is in order. Pressing on the skin and observing the speed of return of blood to the blanched area is not a reliable test. Static blood in dilated capillaries and vessels may simply be temporarily displaced and, upon the release of pressure, rapidly flow back to its original site.

Anesthesia. The thresholds of sensation preception vary greatly in different individuals, and not infrequently patients will be encountered who will not admit subjective feeling of tingling or numbness and yet can be demonstrated to have impaired sensibility to touch and pin prick. It is, therefore, important that the sensation of the parts left uncovered by plaster, usually the fingers and toes, be carefully checked at frequent intervals during the first 24 hours after the application of the cast, especially if other signs or symptoms appear. Motion should also be observed and may, in fact, afford the principal clue to the function of certain nerves, the sensory distribution of which may be largely covered by plaster. A rough, but adequate, examination of the radial, median, and ulnar nerves can be

local ischemia in the absence of generalized edema (Figs. 9 and 10). It is, therefore, essential that every individual concerned with the care of a plaster cast after its application (and the patient himself is not the least of these) be keenly aware of the danger signals. The symptoms are *pain* and *numbness*, and the signs cyanosis, anesthesia, and edema.

Pain. The great majority of fractures and other injuries after reduction or other treatment and immobilization in plaster rapidly and progressively become painless. Undiminished pain four hours



Fig. 10. The window cut from the plaster cast immediately overlying the pressure ulcer illustrated in Fig. 9. Note the prominent ridge, the cause of the ulcer.

after recovery from anesthesia should be regarded with grave suspicion. If it continues unabated for six hours, active measures for investigation and relief must immediately be instituted. Only when the surgeon is quite satisfied that the pain is not the danger signal of a serious complication can morphia be given. Localized pain, usually over bony prominences, must always be investigated. *The patient is always right.* It is far better to cut fifty windows without finding a pressure area than to miss one ulcer. The pain from

overhead. Pillows, no matter how expertly placed, make an insecure perch, may produce dents in the still soft plaster and impede the free circulation of air around the cast. Light cradles should never be used. In unconscious patients they can cause serious burns. Hot-air blowers are a waste of time, since the setting of plaster is a heat-evolving process which will not be accelerated by the addition of more heat. For at least 24 hours, to facilitate drying and inspection, no covering of any sort should be placed over the cast (Fig. 11).



Fig. 11. A cast suspended immediately after application.

Pain, swelling, anesthesia, and motion should be checked at 30-minute intervals. If any signs or symptoms appear, *the surgeon who applied the cast* should be informed at once. In every well-regulated institution, all pressure ulcers, paralysis, and other sequelae of ischemia, occurring as a result of the application of plaster, should be thoroughly investigated and reported at staff meetings. All are preventable and, in fact, occur only very rarely in well-conducted clinics and hospitals. But constant, unrelenting vigilance is necessary. The fact that peroneal palsy has not occurred in a thousand leg casts is no assurance that it will not occur in the one thousand and first,

made in a few seconds by any intelligent attendant. Sensation is checked systematically with a pin over all exposed areas of skin. The patient is then asked to make a fist, to hold a sheet of paper between the thumb and flexed fingers while it is forcibly withdrawn by the examiner, to hyperextend, and, finally, to spread the fingers. It is not necessary, or even desirable, that the nurse or other attendant be too much concerned with which nerves may be involved; it is sufficient that any deviation from the normal be reported at once. In the foot, flexion and extension of the toes are tested and sensation determined, particular attention being paid to the terminal sensory branch of the peroneal nerve on the extensor surface just proximal to the space between the great and second toes. Any abnormality in nerve function must, of course, immediately be investigated. Prompt action will often restore function in a few minutes, although nerve tissue is notoriously delicate. Delay may well result in a palsy of several months duration.

Edema. Moderate edema beyond the distal end of the cast is very common, and, in itself, is of no great consequence, provided it is not increasing and is not accompanied by other signs or symptoms. Frequent observation is essential. Among the first indications of subsiding edema are the return of normal wrinkles and the disappearance of glossiness of the skin.

To avoid complications, some surgeons, as a routine, split all casts immediately after application. This is unnecessary and illogical. It would be as reasonable to give all patients digitalis on admission to hospital on the basis that sooner or later one of them will develop heart failure. If the surgeon believes that sufficient edema to produce ischemia is likely to follow his reduction, manipulation, or operation, the cast should of course be split or bivalved immediately after application. Splitting alone may not decompress a well-made cast. Considerable force may be required to "spring" it. Where indicated, splitting or bivalving must be carried out, but immobilization of the limb is never improved by the procedure, and, as soon as the indication has passed, the cast should be reunited or replaced.

When the patient is returned to his bed after application of a cast, the limb should be elevated above the level of the heart for at least 24 hours. This should be accomplished by suspension from

and the one thousand and first patient will derive cold comfort from knowing that the incidence is only 0.01 per cent. *His* peroneal nerve will be *100 per cent* paralyzed!

THE CUTTING AND REMOVAL OF CASTS

The cutting of a plaster cast requires much patience, gentleness, and care. Hurriedly and roughly done, it can be an ordeal which the patient will never forget. It can even be dangerous. A 14-inch gash in the thigh has been reported.[2] There are no short cuts. No power-driven cast cutter yet devised is completely safe or satisfactory. The basic tool is a sharp plaster knife, grasped in the fingers and guarded with the thumb. Cuts are made to form a V-shaped channel in the plaster (Fig. 12); the blade is never used perpendicular to the surface of the skin (Fig. 13). Plaster cutters are much faster but must be used with caution. The position of the blade beneath the cast must be known at all times. It is extraordinarily easy to include a sizable piece of skin and subcutaneous tissue in a bite. Cutting can be facilitated to some extent by moistening the line of division of the plaster with hydrogen peroxide or vinegar from a medicine dropper. If the cast is not to be replaced, its removal can be greatly facilitated by soaking overnight in wet towels.

The lines along which a cast will be cut or bivalved can usually be anticipated at the time of application. For long casts, a rubber tube ½ inch in diameter, well greased with vaseline, laid over stockinette and padding and under the plaster and withdrawn when the plaster has set, makes the subsequent use of the plaster knife and cast cutter very much easier (Figs. 2 and 68).

When wounds involving the loss of large amounts of tissue in the neighborhood of major blood vessels are immobilized in plaster casts, the danger of secondary hemorrhage under the plaster becomes very real, and large amounts of blood can be lost before the cast can be removed and the hemorrhage controlled. In such cases, it is wise to place a tourniquet of rubber tubing loosely around the limb, proximal to the wound, before the application of padding or plaster

[2] R. Watson-Jones, *Fractures and Joint Injuries* (3rd ed; Edinburgh E. &. S. Livingstone, 1943), I, pp. 175-176.

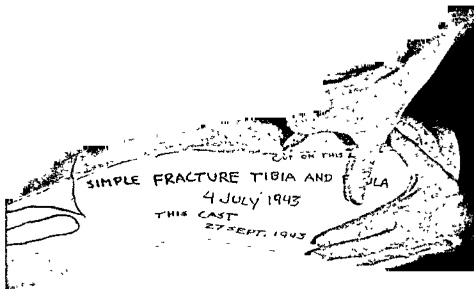


Fig. 12. Correct method of cutting a plaster cast.

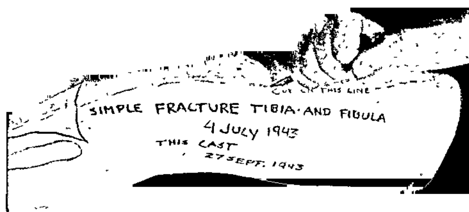


Fig. 13. Incorrect method of cutting a plaster cast.

(Fig. 14). The ends of the tubing are allowed to project through the cast at an easily accessible point. Nurses and other attendants are instructed at the first sign of hemorrhage to draw the ends together out of the cast as far as possible and then call for help.



Fig. 16. Correction of minor angulation by wedging.

When a cast has been bivalved or split, the cut edges should be covered, not only for the sake of neatness but to protect the patient from bits of plaster falling between the cast and the skin. This is accomplished either with adhesive tape or by slipping stockinette over each half of the cast, and binding the ends down with a few stitches or bits of tape (Fig. 15).



Fig. 14. A hip spica applied for a large wound of the posterior aspect of the knee and fracture of the femur. Note tourniquet in place under the plaster for control of secondary hemorrhage.

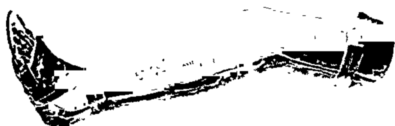


Fig. 15. A bivalved cast; the halves are held together with webbing straps.

leaving the room all these garments are removed at the door and deposited in a clean sheet. They are autoclaved for 20 minutes before laundering. Rubber gloves are soaked in alkaline formalin solution for two hours. Shoes or overshoes are scrubbed with sodium hypochlorite solution [2] and dried in sunshine.

(2) There is *no* traffic in and out of the plaster room while a septic case is in progress. Material needed from the outside is brought to the door and handed in.

(3) Dirty dressings are discarded; casts are collected in a large covered garbage can in which they are transported to the incinerator. After each use the can is washed out and scalded with live steam or scrubbed with sodium hypochlorite solution and dried in sunshine.

(4) Unused gauze sponges and other dressings are autoclaved, laundered, repackaged, and reautoclaved.

(5) Instruments, after use, are soaked in zephiran 10% after cleaning. They are polished but not oiled, and dried. Oil on instruments is potentially very dangerous. Spores in oil can survive high temperatures for long periods of time.

(6) The floor, tables, drainboard, and sink are thoroughly scrubbed with soap, water, and zephiran 10%.

All these precautions are of little avail if the surgeon does not cultivate what might be called a "septic conscience" as contrasted with the "aseptic conscience" of clean surgical procedure. His reflexes must be so canalized that he would no more think of reaching into the clean plaster bin for a roll of plaster bandage while applying a cast to an infected compound fracture than he would reach into a cabinet for an unsterile instrument during a laparotomy.

[2] Carl W. Walter, *Aseptic Treatment of Wounds*, (In press, New York: The Macmillan Company).

Windows for dressings, removal of sutures, or investigation of localized pain must be carefully cut, and, whenever possible, immediately replaced to avoid "window edema." Once edema has occurred through a window, enlargement is futile; the entire cast must be replaced. When a window has been cut and a point of pressure discovered, a piece of soft, thick felt is trimmed to fit the aperture exactly and is held in place by a few turns of plaster bandage.

Wedging is a very efficient and often neglected method for the correction of minor degrees of angulation in fractures of the long bones. The amount of wedging necessary to correct the deformity is calculated from the X-ray. A cut is made with a hacksaw through ¾ of the circumference of the cast, with the intact quarter, as a rule, opposite the apex of the angulation. Care must be taken, however, that the wedging will not produce distraction. Many fractures will require wedging in a reverse fashion, that is, the edges of an excised portion of the cast should be brought together to produce impaction as well as correction of angulation. Tongue depressors are hammered into the cut, or laid in place after "springing" the cast (Fig. 16) until the desired width is obtained, and held in place with 6 or 8 turns of plaster bandage. Angulation in two planes can be corrected by two cuts a few centimeters apart made on successive days. Where two cuts are made, the cast should be reinforced with plaster slabs after the second cut has been wedged.

THE MANAGEMENT OF SEPTIC CASES

The use of plaster casts in the treatment of compound fractures and other septic conditions has raised a number of technical problems with regard to their application and removal. Such casts are frequently literally dripping with pus when changed, and the strictest precautions must be taken to prevent the dissemination of infection and to protect the surgeon and his assistants. For each septic case a routine similar to the following must be followed:

(1) Everyone who enters the plaster room—surgeon, assistant, anesthetist, nurses, orderlies, and visitors—wears cap, mask, gown, gloves, and slippers or overshoes. The last are particularly important, as dressings, plaster, and pus naturally gravitate to the floor. Upon



Fig. 17. The slab in place. The thenar eminence is being freed with radial cuts.

Fig. 18. Binding the wet slab to the forearm with gauze roller bandage.

CHAPTER II

THE UPPER EXTREMITY

THE FOREARM "COCK-UP" SPLINT

Materials Required

One 3-inch roll plaster bandage
Three feet of 6-inch sheet wadding
One 1½-inch roller bandage
Eighteen inches of 3-inch stockinette

Position

The patient either sits or lies supine. The forearm lies on a table, palm upward, with a rolled towel under the wrist supporting it in 30° of extension (dorsiflexion).

Procedure

Two thicknesses of sheet wadding are laid on the flexor surface from the level of the antecubital fold to the base of the fingers. A 12-thickness plaster slab is made to extend from one finger's breadth distal to the antecubital fold to the level of the distal interphalangeal flexion crease of the fifth finger and is laid in place. Two radiating cuts are made medially from the metacarpal-phalangeal joint of the thumb, and the plaster turned back on itself to free the thenar eminence (Fig. 17). The distal end of the slab is accurately folded back on itself parallel to the distal palmar flexion crease. The slab is well rubbed, excess sheet wadding is turned back into the wet plaster and the splint bound to the forearm and palm with one or two thicknesses of gauze roller bandage (Fig. 18). Twenty-four hours later, when the plaster has dried, the splint is removed and covered with stockinette, the ends of which are sewed or taped down. The final splint is held in place by bandages or webbing straps.

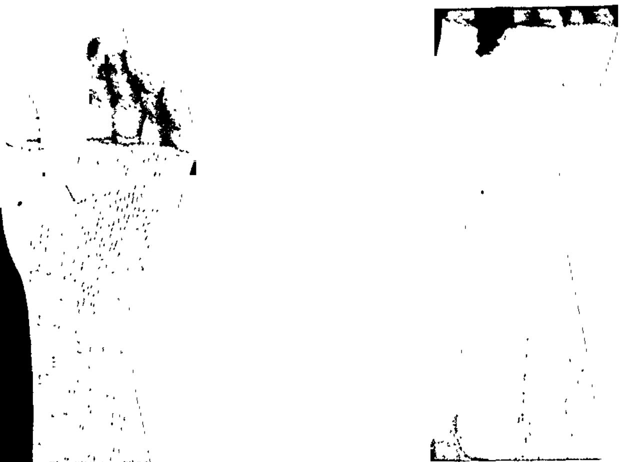


Fig. 19. Stockinette in place for the forearm cylinder. A partial sheath for the thumb has been fashioned and held in place with adhesive tape.

Fig. 20. The forearm and hand in position, and fitted with stockinette for the forearm cylinder. Note individual stockinette sheath for the thumb. The volar slab is in place.

REMARKS

Since the volar "cock-up" splint really immobilizes almost nothing in the hand, wrist, or forearm, its usefulness is limited. Its chief virtue is ease of removal and reapplication. The proper degree of "cock-up," or extension of the wrist, for most purposes is easily gauged by placing the flexor surface of the forearm on the table with the fist clenched.

THE FOREARM CYLINDER

MATERIALS REQUIRED

Four rolls of 3-inch plaster bandage
Eighteen inches of 3-inch stockinette
Three strips of ½-inch adhesive tape 3 inches long

POSITION

The patient either sits or lies supine. The elbow rests on the table and the forearm is held vertical by the patient midway between full pronation and supination, with the wrist in 30° of extension (dorsiflexion). The thumb and thumb metacarpal are adducted, or rolled toward the palm, until the tips of the index finger and thumb oppose easily.

PROCEDURE

Stockinette is fitted from the elbow to the level of the tip of the thumb. Both layers of stockinette between the thumb and index finger are cut down to the thenar web and fastened together with adhesive tape or thread to form a mitten (Fig. 19). Two 6-thickness slabs are made to extend from one finger's breadth above the antecubital fold to the distal palmar crease and the middle of the metacarpal heads respectively. The slabs are molded into place (Fig. 20) and anchored with circular turns in the palm. Turns are taken around the base of the thumb up to, but not beyond, the metacarpal-phalangeal joint. Care should be taken to avoid building up an unnecessarily large mass of plaster at the thenar web. When the



Fig. 22. The completed marked forearm cylinder.



Fig. 23. The completed forearm cylinder, palmar aspect. Note apposition of thumb and forefinger.

second circular roll is half used up, the excess stockinette is trimmed away and cuffs turned down and held with the remaining plaster bandage. As a final step the surgeon molds the cast firmly on to the hand by holding his thumbs against the palm and his fingers against the dorsum until the plaster has set (Figs. 21, 22, and 23).



Fig. 21. Molding the forearm cylinder to the hand.

Remarks

Properly applied without padding, this cast effectively immobilizes the carpus, and, therefore, finds its most frequent use in the treatment of fractures of the scaphoid. Although recommended by

motion of the thumb, and fixation in abduction makes it almost impossible for the patient to slip into a shirt or coat. Furthermore, any finger joint, immobilized for the ten or twelve weeks usually required for the healing of a fracture of the scaphoid, will need a long period of mobilization and may be permanently injured.

For fractures of the thumb metacarpal not requiring traction, the thumb must be included in plaster to the distal joint. A third plaster slab should be used on the radial side of the forearm, folded around the thumb and very carefully molded into the "anatomical snuff box" and base of the metacarpal (Fig. 24).

The forearm plaster cylinder is, of course, worse than useless for any fractures of the bones of the forearm, since it does not immobilize the proximal radio-ulnar joint.

THE FOREARM AND FINGER CYLINDER

Materials Required

Five rolls of 3-inch plaster bandage
Twenty-one inches of 3-inch stockinette

Position

Same as for Forearm Cylinder. The proximal phalanx is flexed to 90° and the middle phalanx, if included in the cast, is flexed to 75°.

Procedure

Stockinette is fitted from the elbow to the fingertips and a hole cut large enough to admit the thumb but not the thenar eminence. With needle and thread an individual sheath is fashioned over the finger to be included in the cast. Dorsal and ventral slabs are measured from one finger's breadth distal to the antecubital fold to either the distal or proximal interphalangeal joint, depending on whether the cast is applied to fix the metacarpal or proximal phalanx. The slabs are made of 6 thicknesses of plaster bandage and loosely laid in place. With scissors they are rapidly trimmed at their distal ends down to the distal palmar flexion crease and the middle of the metacarpal heads, except for extensions along the involved finger

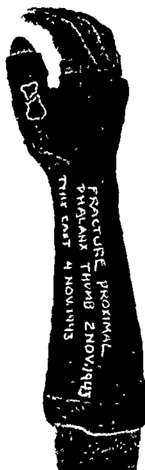


Fig. 24. The forearm cylinder with thumb included for certain fractures not requiring traction.

some authorities,[1] [2] *it is generally accepted that fixation of the* thumb in abduction and carrying plaster beyond the metacarpal phalangeal joint are unnecessary and unwise.[3] [4] [5] Either procedure will almost completely disable the hand by preventing opponens

[1] Soto-Hall, R., and Haldemann, K. O., "Treatment of Fractures of the Carpal Scaphoid," *Journal of Bone and Joint Surgery*, October, 1934, 16–4 pp. 822–828.

[2] Speed, Kellogg, *A Textbook of Fractures and Dislocations* (4th ed ; Philadelphia: Lea and Febiger, 1942), p. 581.

[3] Thorndike, A., Jr , and W. Garrey, "Fractures of the Carpal Scaphoid," *New England Journal of Medicine*, 1940, 222, pp. 827–830.

[4] Bohler, L., *Treatment of Fractures* (4th Eng. ed ; Baltimore: Wm. Wood & Co., 1936), p. 247.

[5] Watson-Jones, R., *Fractures and Joint Injuries* (3rd ed.; Edinburgh: E. & S. Livingstone, 1943, II, p. 558.

which are left slightly narrower than half the finger's circumference. The thenar eminence is freed with two radial cuts and the flaps turned back. While the assistant holds the ends of the slabs and the finger in flexion with one hand and the other fingers in extension with the other, a full roll of plaster is used to bind the slabs in place (Fig. 25). Another 6-thickness slab, 8 inches long and 1 inch wide, is then made and laid as a reinforcement along the dorsum of the finger, hand, and wrist. This is held in place by a few more circular turns. At this point the plaster already applied is usually on the verge of setting, and the surgeon should devote himself to molding for the next five or ten minutes, one hand being devoted to the finger and the other to pressure with the thumb and finger against the palm and dorsum. When set, the stockinette cuffs can be turned back and fixed with a few final turns of circular bandage (Fig. 26).

REMARKS

Fingers do not lend themselves to convenient mechanical control, and this cast, therefore, can be quite difficult to fashion without intelligent assistance or active co-operation from the patient. Care should be taken to avoid building up uncomfortable or unsightly bulkiness on the sides of the fingers.

If traction on the flexed finger is indicated, it can easily be achieved by removing the extensor half of the finger portion of the cast and leading the elastics to a small wire loop overlying the distal end of the radius. The loop is twisted in #12 iron wire, and the ends, about 2 inches in length, bent against the flexor surface of the cast and held with a few circular turns of plaster bandage (Fig. 27).

It should be remembered when immobilizing or fitting traction to fingers that in flexion they do not lie parallel to the metacarpals but obliquely, the fingertips pointing toward the styloid of the radius.

THE BANJO SPLINT

MATERIALS REQUIRED

Four rolls of 3-inch plaster
Eighteen inches of 3-inch stockinette
Thirty-two inches of 12- or 14-gauge iron wire

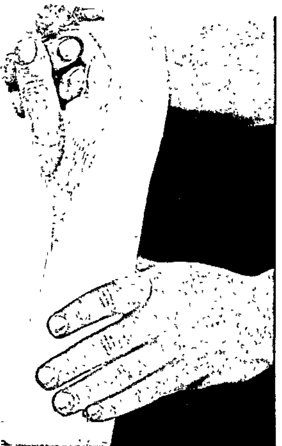


Fig. 25. Stockinette and slabs in place for a forearm and finger cylinder.

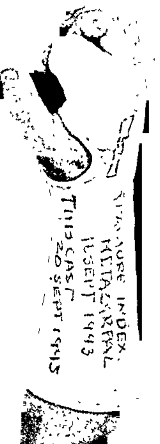


Fig. 26. The completed forearm and finger cylinder.



Fig. 28. The completed marked banjo splint.

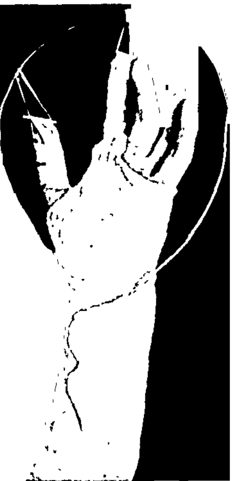


Fig. 29. The completed banjo splint. The course of the wire under the plaster is marked.

Position

Same as for the Forearm Cylinder.

Procedure

Stockinette is fitted to the hand and forearm and individual sheaths fashioned with needle and thread for fingers which may be

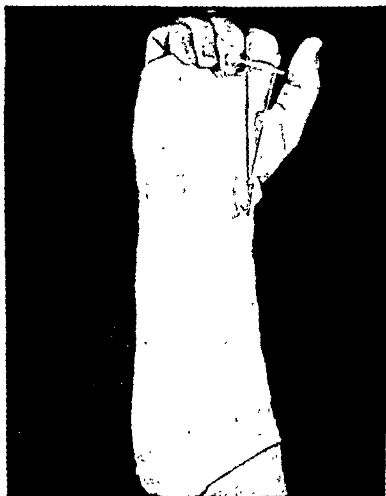


Fig. 27. The forearm and finger cylinder adapted for traction.

partially encased in plaster. With the hands and pliers the wire is bent so that, starting in the middle of the extensor surface of the forearm, it forms a "Z," then curves around to the "anatomical snuff box," sweeps over the extended fingers about 1½ to 2 inches from



Fig. 30. A traction splint for a single finger.

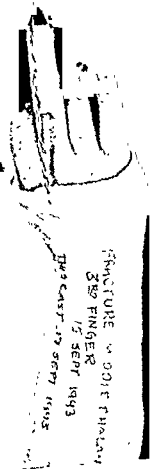


Fig. 31. A traction splint for a single finger, dorsal aspect.

their tips to the distal end of the ulna and ends in a "Z" on the flexor surface. Eight-thickness slabs are made as in Forearm Cylinder with Finger Extension and held in place with a few turns of plaster bandage. The wire is then fitted into place over the slabs and held with several turns of plaster bandage. Cuffs of stockinette are trimmed, turned back and held in place as usual (Figs. 28 and 29).

REMARKS

The purpose of the banjo splint is to provide a solid anchor for traction for fractures of the metacarpals and phalanges. It should always be based on a cylindrical cast. A "banjo" anchored in a dorsal or "cock-up" splint is almost certain to slip. The plaster cylinder must be well molded into the extended or cocked-up palm and about the dorsum of the hand to provide a firm basis for countertraction. The full banjo is indicated only for injuries requiring traction on several fingers including the thumb. If the thumb does not require traction, it should be left free, with the wire emerging from the plaster just proximal to the index metacarpal-phalangeal joint. Frequently a single finger or thumb alone requires traction. This is conveniently achieved by a single wire laid against the extensor surface slab, arching out to a point 1½ to 2 inches from the fingertip. A small loop or hook is fashioned in the end of the wire. Elastics should be anchored to the wire loop with adhesive tape to prevent slipping (Figs. 30 and 31).

THE DISTAL PHALANX CYLINDER

MATERIALS REQUIRED

One roll of 3-inch plaster bandage

POSITION

The patient sits at a narrow table with the surgeon sitting opposite.

PROCEDURE

No padding is used. An 8-thickness slab is made, ¾ inch wide and equal in length to the distance from the extensor aspect of the metacarpal-phalangeal joint, around the tip of the finger and

REMARKS

Although useful for many injuries of the middle and distal phalanges, this cast is most frequently employed for "baseball" or "mallet" finger. The position for immobilization of this injury is that of greatest relaxation of the distal slip of the extensor tendon mechanism, 90° flexion at the proximal interphalangeal joint and hyper-



Fig. 33. The completed distal phalanx cylinder.

extension of the distal joint.[6] [7] It is not an easy cast to apply, and a smooth, fast setting plaster of the "fixed" type is a great advantage.

Considerable patience is required, and the surgeon should rest his arm comfortably and strongly resist the temptation to move his fingers until the slab is quite firm. Strips rather than a roller bandage are used to bind the slab in place because of the difficulties in passing a roller between the fingers. Care should be taken to avoid building up uncomfortable bulk on the lateral aspects of the finger.

[6] Smillie, I. S., "Mallet Finger," *British Journal of Surgery*, January 1937, 24–95: pp. 439–445

[7] Bunnell, Sterling, "Surgery of the Intrinsic Muscles of the Hand other than those Producing Opposition to the Thumb," *Journal of Bone and Joint Surgery*, 1942, XXIV pp. 149–152.

back down the flexor surface to the metacarpal-phalangeal flexion crease. The slab is laid in place along the flexor and extensor surfaces of the finger and is held until it sets. The surgeon holds the proximal phalanx between the thumb and fingers of his left hand and molds the plaster over the distal phalanges with his right (Fig. 32). When the



Fig. 32. Slab in place for immobilization of a distal phalanx.

slab has set, it is anchored by eight to twelve strips of plaster bandage, each 6 inches long and 1 inch wide (Fig. 33). If the cast is to be exposed to unusual wear and tear, a metal splint ¾ inch wide cut from a tin can be incorporated between the slab and the circular strips.

fixed to the table leg with a 1-inch strip of adhesive tape passed across the middle phalanges. A pillow is placed between the upper arm and the table, if necessary. The degree of flexion at the elbow is adjusted by moving the patient close to the edge of the table and moving the



Fig. 35. Construction of the full-arm splint. The reinforcing iron rod has been laid in position against the first slab.

hand up and down the table leg. The wrist is in moderate extension (Fig. 34).

PROCEDURE

A slab is measured from the middle of the metacarpal heads, if the forearm is to be supinated, or the distal palmar *flexion* crease, *if*

Bathing becomes a real problem to the patient but can be accomplished without danger to the cast if the hand is slipped into a large, heavy household type of rubber glove with two stout elastics over the wrist.

THE FULL-ARM SPLINT

MATERIALS REQUIRED

Two six-inch rolls of plaster bandage
Forty-eight inches of sheet wadding, 6 inches wide
Twenty-six inches of ¼-inch iron rod
Fifteen inches of 6-inch stockinette
Fifteen inches of 3-inch stockinette

POSITION

The patient lies prone on a table, well over to one side. The arm to be splinted is abducted and the elbow flexed over the edge with the forearm lying along one of the table legs. The forearm is adjusted to the degree of pronation or supination desired, and the hand is



Fig. 34. Position for application of the full-arm splint.

REMARKS

Like the forearm "cock-up" splint, the chief virtue of the full-arm splint is its ease of removal and replacement. It lacks the inherent strength of the plaster cylinder and is weak at the elbow. A splint can be made without iron-rod reinforcement, but, if strong enough to support the weight of the forearm at the elbow, it will be unduly heavy.

THE FULL-ARM CYLINDER

MATERIALS REQUIRED

Twenty-eight inches of 3-inch stockinette
Six rolls of 3-inch plaster bandage

POSITION

The elbow is almost always flexed at 90°. One of three positions is used, depending on the circumstances of the case and, to some extent, the preference of the surgeon:

(1) The patient lies prone, with the pelvis and the thorax slightly over the side of the table and the end of the table at a level halfway

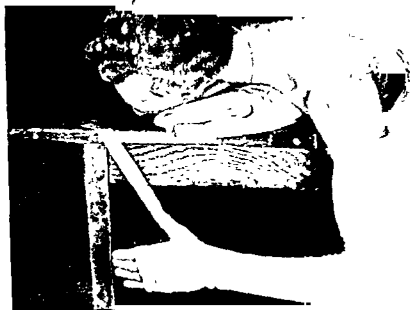


Fig. 37. Position (1) for application of the full-arm cylinder.



Fig. 36. The full-arm splint in position.

it is to be pronated, to a level one finger's b. adth distal to the posterior axillary fold. The iron rod is cut 1 inch shorter than the length of the slab and is carefully bent to fit the curves of the elbow, wrist, and palm. Two thicknesses of sheet wadding are laid in place, overlapping somewhat to cover about ¾ of the circumference of the arm. A 6-thickness slab is made and molded into place. If the forearm is in pronation, the thenar eminence is freed with radial cuts. Throughout its length, the edges of the slab are turned back so that *at all points the splint covers half the circumference of the arm.* The iron rod is laid in place (Fig. 35) and covered with a second slab which is molded well around it and into the first. The edges of the sheet wadding are turned back into the plaster. The hand and forearm portion of the splint is bound in place until it sets with turns of roller bandage which include the table leg if the elbow is flexed to 90°. When firm, the entire splint is bound to the arm with roller bandage. Twenty-four hours later, or when the plaster is quite dry, the cast is removed and covered with stockinette, the 6-inch portion above the elbow and the 3-inch below. The two portions are joined and the ends closed by sewing (Fig. 36).

tape. The long extensor strip is then fastened to the table edge near the patient's opposite shoulder (Fig. 37).

(2) The patient lies supine, with the shoulder well beyond the edge of the table and directly above the table legs. Adhesive tape is



Fig. 39. Position (2) for application of the full-arm cylinder.

applied to all the fingers as in Position (1), except that the extensor strips are 10 inches in length, and a double thickness is used on the thumb. Holes are punched or cut in the center of the ends of an ordinary 12-ounce cylindrical tin can and a 12-inch length of broomstick or similar piece of wood or pipe thrust through. The can is

between the nipples and the clavicles. If the position is uncomfortable or the table top does not project beyond its legs, a 5- or 6-foot board such as an ironing board can be laid between the table and the patient's body and out beyond the edge to serve as a support for the

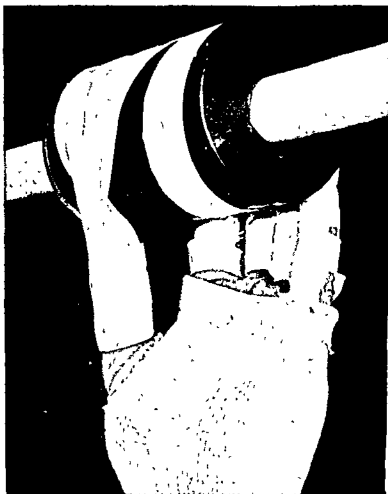


Fig. 38. Method of anchoring the hand for application of the full-arm cylinder in positions (2) and (3).

upper thorax and head. The terminal 4 inches of a 16-inch strip of 1-inch adhesive tape is fastened to the extensor surface of the thumb, which has previously been painted with tincture of benzoin. A 6-inch strip of tape is fastened to the flexor surface and to the extensor strip. The two are bound quite firmly to the thumb with ½-inch

deviation at the wrist can be controlled to a considerable extent by adjustment of the overhead traction rope on the loop between the ends of the broomstick (Fig. 39).

(3) This is the same as for Position (2), except that the forearm is parallel to the body. The long broomstick is lashed to the table top above the patient's head, and a similar broomstick near the patient's feet provides a point of traction on the hand (Fig. 40).

PROCEDURE

Stockinette is fitted with a hole for the thumb before the arm is fixed in position. No other padding is ordinarily used. The greased rubber tube is laid in place on the medial or lateral aspect. Eight-

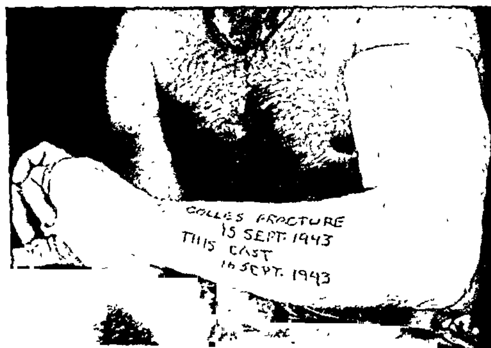


Fig. 41. The completed full-arm cylinder.

thickness slabs are measured and molded in place on the flexor and extensor surfaces from the middle of the metacarpal heads and the distal palmar flexion crease to a level one finger's breadth distal to the anterior axillary fold. The edges of the slabs are cut and folded on each other at the elbow. The slabs are carefully overlapped in the forearm, and the thenar eminence is freed with radial cuts. Two rolls of plaster bandage are used to bind the slabs together and to the

prevented from sliding from its position in the center of the broomstick by small nails or adhesive tape. A 26-inch length of clothesline or other light rope is then passed through holes drilled across each end of the broomstick and each end firmly knotted. An overhead traction rope is fastened to the loop thus formed. The surface of the can is painted with tincture of benzoin. The long strips of adhesive tape from the fingers are carefully and firmly applied to the can so

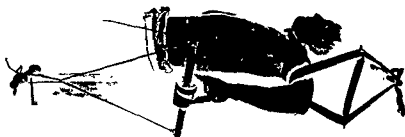


Fig. 40. Position (3) for application of the full-arm cylinder.

that the distal row of phalanges is in contact with its surface. The thumb strip is applied on the opposite side near the end so that the distal phalanx lies against the can but so that a good space remains between it and the thenar web (Fig. 38). A broomstick or similar piece of wood or pipe is lashed to the table legs a few inches from the floor, with its end projecting parallel to and directly beneath the upper arm. A sling of flannel bandage with a felt pad and a spreader of wood is adjusted between the upper arm and the broomstick. The entire arm is fixed firmly in position by traction from above. Pronation and supination are controlled by the short length of broomstick, which can be anchored at any point of rotation by leading a cord from either end to any convenient solid object. Radial and ulnar



Fig. 42. Position (1) for application of the clavicular "figure 8" splint.

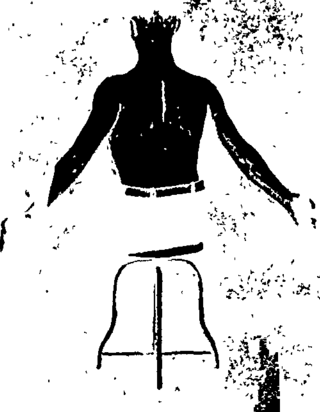


Fig. 43. Position (1) for application of the clavicular "figure 8" splint, front view.

arm, but no circular turns are taken over the upper arm sling. The cast is carefully molded to the palm and the dorsum of the hand as in the "Forearm Cylinder." The surplus stockinette is turned back at the ends and held with the last few turns, which also cover the gap left after removal of the upper arm sling and its pad (Fig. 41).

REMARKS

The full-arm cylinder immobilizes the wrist, forearm, and elbow. Although it does not immobilize the upper arm, it is useful in the treatment of many fractures of the humerus as a "hanging" cast. Position (1) is particularly suitable for this. The traction apparatus described for Positions (2) and (3) can be used in the reduction of many fractures of the radius and ulna. The pronation, ulnar deviation, and complete fixation of the proximal radio-ulnar joint required for overcoming the "supination twist" of the distal radial fragment in the immobilization of Colles' fracture [8-11] is easily achieved in Positions (2) and (3) by rotation and anchoring of the short length of broomstick.

THE CLAVICULAR "FIGURE 8" SPLINT

MATERIALS REQUIRED

Four feet of 6-inch stockinette
Three 6-inch rolls of plaster bandage
Three pieces of felt ½ inch in thickness:
- Two strips, 10 x 2 inches
- One piece, 8 x 4 inches

POSITION

Either of two positions may be used. The second is usually easier for the patient, effects reduction of many fractures of the clavicle without further manipulation, and results in a more closely molded cast.

[8] Cotton, F. J., *Dislocations and Joint Fractures* (2nd ed., Philadelphia: W. B. Saunders Co., 1924) pp. 364–365 and 392–393.
[9] Lambrinudi, C., "Injuries to the Wrist," *Guy's Hospital Gazette*, 1938, 52: pp. 107–117.
[10] Taylor, Grantley W., and Parsons, L. C., "The Role of the Discus Articularis in Colles Fracture," *Journal of Bone and Joint Surgery*, 1938, XX, 1: pp. 149–152.
[11] Mayer, J. H., "Colles Fracture," *British Journal of Surgery*, 1940, 27: pp. 629–642.

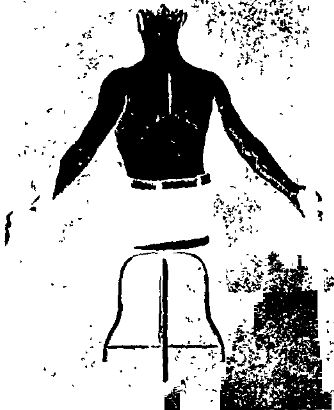


Fig. 42. Position (1) for application of the clavicular "figure 8" splint.

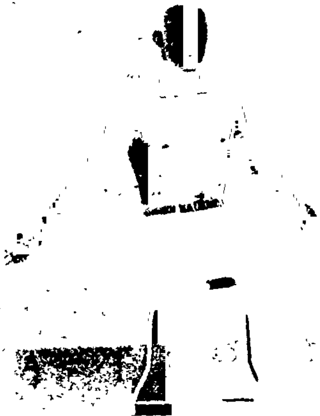


Fig. 43. Position (1) for application of the clavicular "figure 8" splint, front view.

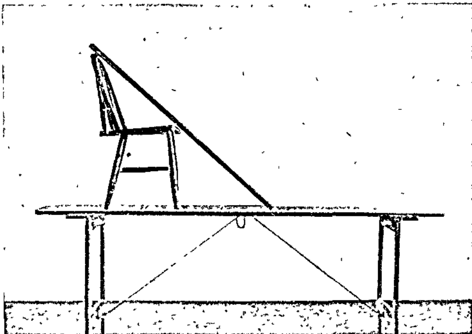


Fig. 44. Chair, broomstick, and table in place for Position (2), application of the clavicular "figure 8" splint.

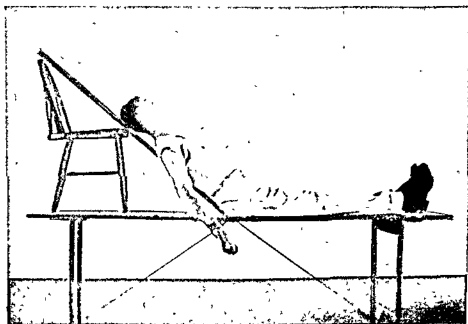


Fig. 45. Position (2) for application of the clavicular "figure 8" splint.

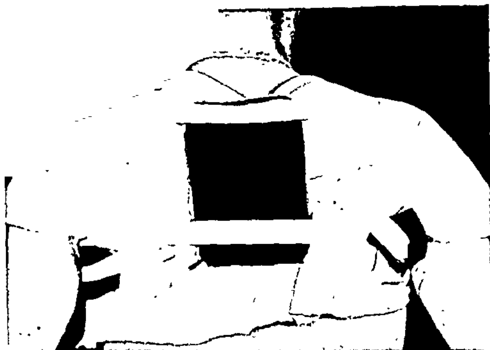


Fig. 46. Padding in place for the clavicular "figure 8" splint.



Fig. 47. Application of the clavicular "figure 8" splint, Position (1). Note the turn of bandage going *over* the shoulder pulling it outward, backward, and downward—not upward.

(1) The patient sits erect on a stool between two tables or chairs, with the shoulders held back and downward. The arms are held at an angle of about 30° from the body, with the elbows straight. The hands grasp the legs of the tables or the seats of the chairs about 30° behind the vertical axis of the body. Care is taken



Fig. 48. Molding the mid-back of the clavicular "figure 8" splint in Position (1).

that the shoulder is not elevated but is held backward and downward (Figs. 42 and 43).

(2) A kitchen chair is placed on a table near its end and is lashed in place, if necessary, to prevent slipping. A broomstick is laid against the seat of the chair at an angle of about 45° from the surface of the

table (Fig. 44). The patient, after the fitting of stockinette and padding, lies with the vertebral column against the broomstick and the arms hanging free over the sides of the table (Fig. 45).

PROCEDURE

The stockinette is split and cut in two. Each piece is passed over the front of the shoulder, with the ends over the clavicles above and through the axilla below. The four ends are overlapped in the mid-

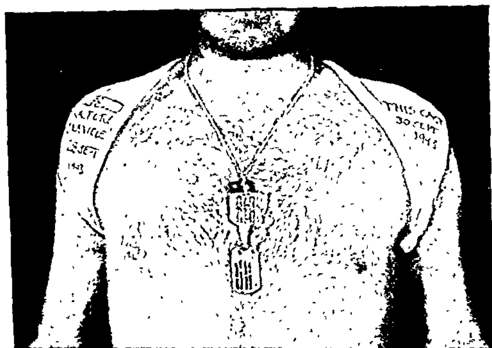


Fig. 49. The completed clavicular "figure 8" splint.

dorsal region and held together with a few stitches or adhesive tape. The two strips of felt are placed in each axilla and held with tape or stitches. The large piece of felt is fastened over the overlapping ends of stockinette between the scapulae (Fig. 46). No plaster slabs are used. Plaster is laid on, beginning at the large felt pad, passing over the affected shoulder to cover the outer half of the clavicle, under the axilla, where it is molded into a narrow rope against the felt strip, then fanned out across the back to cover its point of origin and over the other shoulder and through the axilla to cross its point of origin again (Fig. 47). All three rolls of plaster bandage are

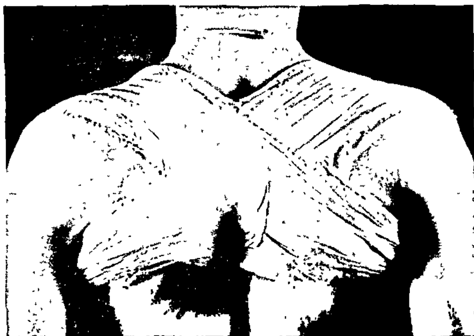


Fig. 50. The completed clavicular "figure 8" splint, back view. Note molding between the scapulae.



Fig. 51. Removal of broomstick, Position (2), application of the clavicular "figure 8" splint.

applied in this "figure 8" fashion. Great care is exercised to avoid undue tightness against the inner aspect of the arm or large masses of plaster in the axilla. The last few turns of bandage are used to hold down the turned-back edges of stockinette. The cast is molded to both clavicles and the groove over the spinous processes as it sets



Fig. 52. Broomstick replaced outside plaster, Position (2), application of the clavicular "figure 8" splint.

(Figs. 48, 49, and 50). When Position (2) is used, the plaster, except for the final trimming turns, is applied over the broomstick. The broomstick is then removed and replaced outside the cast (Figs. 51 and 52). The patient remains in position, lying against the broomstick until the plaster has set.

Remarks

This cast is used only for fracture of the clavicle. Immobilization is not complete but is adequate. A wide range of painless motion of the shoulder is usually possible within a day or two of reduction and fixation. Novocain infiltration of the fracture site provides satisfactory anesthesia. Reduction can be carried out, when necessary, by direct manipulation of the fragments from behind the patient as he sits or lies in the positions described. Elevation of the shoulder should be avoided. When elevated in the presence of a broken clavicle, the scapula is brought toward the apex of the truncated cone of the thorax and closer to the vertebral column. The distance between the acromion and the sternum is shortened, and bowing or overriding occurs at the fracture site. For this reason, the plaster bandage should be applied as described—over the shoulder and down through the axilla from front to back. If applied in the opposite direction, there would be a tendency to elevate the distal fragment.

The commonest error in applying the clavicular "figure 8" splint is to make the axillary portions of the cast too wide and bulky. This results in a very uncomfortable splint which can even be dangerous. Paralysis of the radial nerve from compression between the humerus and the plaster has been known to occur.

THE THORACOBRACHIAL SPICA

Materials Required

Twenty rolls of 6-inch plaster bandage
Twenty-four inches of 9-inch stockinette
Twenty-eight inches of 3-inch stockinette
Felt pads: One 4 x 16 inches
Two 4 x 8 inches
Forty-four inches of ¼-inch iron rod

Position

Either of two positions may be used. The second is applicable to the unconscious patient and to unstable fractures of the elbow, humerus, or shoulder.

(1) Two broomsticks or similar pieces of wood or pipe are lashed upright to the corners of a table. The patient sits on a stool facing the table opposite the right-hand broomstick, if the right arm is to be encased in plaster. The arm is placed in the position in which it is to be immobilized and temporarily held by an assistant. The patient and stool are then moved until the fingers lie against the



Fig. 53. Position (1) for application of the thoracobrachial spica.

broomstick and the forearm is parallel to the end of the table. The middle and distal phalanges are then firmly fastened to the broomstick with 1-inch adhesive tape. In pronation or supination, all four fingers lie against it; in mid-position, it passes between the third and fourth. A sling with pad and spreader is carried from the other broomstick to the elbow (Fig. 53).

(2) Two tables of equal height are separated approximately the distance between the patient's occiput and ischial tuberosities. Two

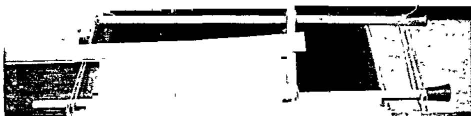


Fig. 54. Broomsticks and board in place between two tables for Position (2) for application of the thoracobrachial spica.



Fig. 55. Position (2) for application of the thoracobrachial spica.

broomsticks or similar pieces of wood or metal are lashed or otherwise fastened between the tables along their edges. A third broomstick is lashed across the first two, about two-thirds of the distance from one table to the other. From the center of this transverse broomstick a smooth thin board, about 4 x 24 x ½ inches, is laid to the more distal table (*Fig.* 54). The patient is laid supine between the tables, with the cervical and dorsal spine against the board. The end of the board lies at the apex of the lumbo-dorsal curve. The

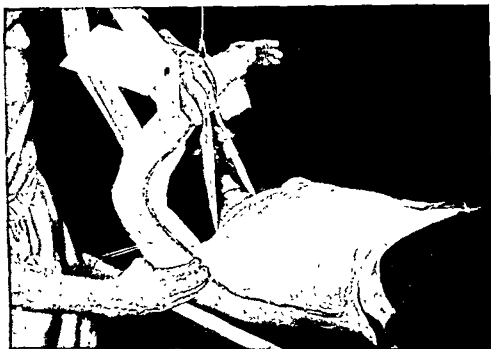


Fig. 56. Application of the thoracobrachial spica in Position (2). Slabs (1) and (2) are in place and have been held with circular and "spica" turns. The reinforcing iron rod is being laid in place.

buttocks fall into the space between the transverse bar and the table carrying the patient's legs. An assistant holds the arm temporarily in the position in which it is to be immobilized. A 1-inch strip of felt is firmly sewed around the wrist. A narrow flannel bandage is passed under the cuff thus formed, around the patient's neck and underlying board and tied to itself to form a sling. Another bandage is carried from the opposite side of the cuff to an overhead traction rope, which is pulled tight. The table or overhead rope is adjusted until the two slings on the wrist are in the same line. A sling with

felt pad and spreader is fitted to the forearm and tied to a second traction rope, which is parallel to the shaft of the humerus. This rope may be overhead or lateral, depending on the position of the shoulder (Fig. 55).

PROCEDURE

Stockinette and padding are fitted before fixing in position. The large size stockinette is slipped over the thorax and sewed over the affected shoulder and to the 3-inch piece covering the arm. The long piece of felt is taped or sewn over the spinous processes, and the smaller pieces are fastened over the iliac crests. If Position (2) is used, the outer surface of the board may be covered with newspaper or one layer of sheet wadding to facilitate removal. The greased rubber tube, if used, is laid along the extensor surface of the arm to the neck and then downward along the nipple line. Slabs are measured as follows:

(1) From the distal palmar flexion crease along the flexor surface of the arm to the axilla and down to a point three fingers' breadth below the iliac crest.

(2) From the wrist along the extensor surface of the arm, across the top of the shoulder, over the opposite scapula, and around and below the axilla to the sternum.

(3) From the seventh cervical to the twelfth dorsal vertebra.

(4) Around the body at the level of the iliac crest.

The iron rod is cut 1 inch shorter than slab (1) and is carefully bent to exact shape. All slabs are made of 6 thicknesses of plaster bandage. Slabs (1) and (2) are made and laid in place. Notches are cut opposite slings, so that the flannel bandage does not become incorporated in the overlapping plaster slabs and can easily be withdrawn later. The slabs are bound in place by circular turns on the arm and body. "Spica" turns are taken at the shoulder, the bandage passing first around the upper arm, then around the thorax, and crossing at the apex of the shoulder. Slabs (3) and (4) are incorporated into the circular turns as soon as they are completed. Slab (4) is laid in place with the center of its lower edge against the transverse bar. It is carried around anteriorly to the umbilicus, arching downward over each iliac crest. The transverse bar, or broom-



Fig. 57. The completed thoracobrachial spica.



Fig. 58. The completed thoracobrachial spica, side view.

stick, is not included in the cast. The iron bar is laid in place and is covered with a second slab (1) (Fig. 56). It is held in place by further circular and "spica" turns. The completed cast should be between 6 and 8 layers in thickness, except where reinforced by slabs. When the arm slabs have set, slings and their pads are withdrawn and the gaps closed with a few turns of plaster bandage. The long flexor slab is molded to the palm, dorsum or ulnar aspect of the



Fig. 59. The completed thoracobrachial spica, back view.

hand, depending on whether the forearm is fixed in pronation, supination, or mid-position.

Redundant stockinette and padding are cut away, the edges turned back and held with a final layer of plaster bandage. The greased rubber tube is withdrawn from its turn at the neck. Irregularities formed by the broomstick are trimmed away and covered with one or two layers of plaster bandage (Figs. 57, 58, 59, and 60).

REMARKS

The thoracobrachial spica effectively immobilizes the shoulder girdle, humerus, elbow, and forearm. When properly constructed it is quite comfortable, the weight being borne largely by the ilia.

Many surgeons carry a reinforcing rod or strut from the elbow or forearm directly to the body of the cast. This is not advised, since without it patients can wear bathrobes and even shirts and jackets without difficulty (Fig. 60). Some patients will suffer distress, espe-



Fig. 60. The completed thoracobrachial spica. A bathrobe can be worn without difficulty if a strut is not used between the arm and the body of the cast.

cially after large meals, unless the abdominal part of the cast is cut out well up to the costal margin. Position (2) does not lend itself to quite as well-fitting a cast as Position (1), but is almost always to be preferred to makeshift apparatus which is practically certain to slip during recovery from anethesia.

CHAPTER III

THE LOWER EXTREMITY

THE POSTERIOR LEG SPLINT

Materials Required

Two rolls of 6-inch plaster bandage
Two pieces of ¼-inch iron rod:
  One 24 inches long
  One 14 inches long
Six feet of 6-inch sheet wadding

Position

The patient lies prone, the lower leg supported on a pad or small pillow and the foot projecting beyond the end of the table.

Procedure

Two 3-foot strips of sheet wadding are laid on the posterior and lateral surfaces of the foot and ankle, overlapping enough to cover three-quarters of the circumference of the limb. The long iron rod is bent to fit the curve of the mid-line of the calf, heel, and foot to the metatarsal-phalangeal joints. The short length of iron rod is bent to form an arch parallel to the ends of the toes and a finger's breadth beyond them. The sides of the arch are bent to lie along the lateral and medial aspects of the sole. Two 8-thickness slabs are made to extend from a finger's breadth distal to the popliteal space to the metatarsal-phalangeal joints. These are laid in place so that they overlap in the mid-line, and together they cover slightly more than half the circumference of the limb. The long iron rod is laid in place between the overlapping slabs (Fig. 61). The short rod is covered with lateral and medial slabs, turned back on themselves, except for the arch beyond the toes, which remains as a "bumper." The excess



Fig. 61. The long reinforcing iron being laid in place between the two overlapping slabs of the posterior leg splint.

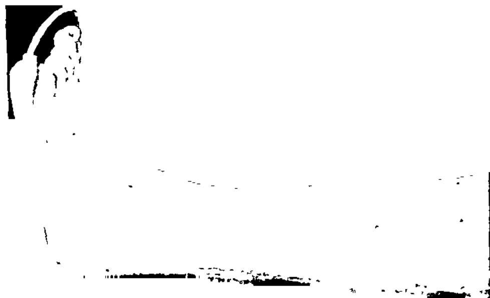


Fig. 62. The completed posterior leg splint.

sheet wadding is turned back along the edges together with a narrow strip of plaster to form a "bead." The entire splint is then firmly bound to the leg and foot with roller bandage. Twenty-four hours later, the splint is removed and covered with stockinette, the ends of which are turned in upon themselves and sewn or held with adhesive tape (Fig. 62).

REMARKS

The entire leg can be splinted by carrying the slabs and rod to the level of the ischial tuberosity. Flexion at the knee can be controlled by adjusting the height of pillows or pads under the lower leg, or the splint can be carried only from the buttock to the ankle. If it is desired to prevent flexion of the toes, the slabs can be carried beyond and over the iron rod forming the "bumper." The purpose of the "bumper" is fourfold. it keeps bedclothes off the toes (an especially important point in aged and malnourished patients), provides a convenient point for suspension of the splint and leg, allows free and full motion of the toes, where this is desirable, and protects them from "stubbing" when the patient is walking on crutches.

A posterior splint can be made without reinforcing iron rods, but to achieve the same strength, particularly at the ankle and knee, requires a great deal more plaster, and the result is proportionately heavy and bulky.

THE PLASTER BOOT

MATERIALS REQUIRED

Eight rolls of 6-inch plaster bandage
Thirty-two inches of 3-inch stockinette
Four pieces of ½-inch felt
  Three 3 x 3 inches
  One 2 x 13 inches
Fourteen inches of ¼-inch iron rod
For treads Two 2-inch cross sections of a small automobile tire
  Two blocks of sponge rubber or felt 2 x 3 x 1½ inches



Fig. 63. Position (1) for application of the plaster boot.



Fig. 64. Position (2) for application of the plaster boot.

sheet wadding is turned back along the edges together with a narrow strip of plaster to form a "bead." The entire splint is then firmly bound to the leg and foot with roller bandage. Twenty-four hours later, the splint is removed and covered with stockinette, the ends of which are turned in upon themselves and sewn or held with adhesive tape (Fig. 62).

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Fourteen inches of ¼-inch iron rod
For treads: Two 2-inch cross sections of a small automobile tire
    Two blocks of sponge rubber or felt 2 x 3 x 1½ inches

Fig. 66. The anterior slab in place. The posterior slab is being turned back on itself at the metatarsal-phalangeal joint level.

Fig. 67. The transverse and longitudinal arches are being molded.

POSITION

One of three positions may be used, depending on the circumstances of the case:

(1) (Fig. 63.) The patient lies supine. The leg is fitted with 3-inch stockinette from the level of the lower edge of the patella to 8 inches beyond the toes. A tongue depressor, or similar piece of wood, is fitted inside the stockinette just beyond the toes, and the end of the stockinette beyond is tied to an overhead rope. The entire leg is elevated, with the knee fully extended until the heel is about

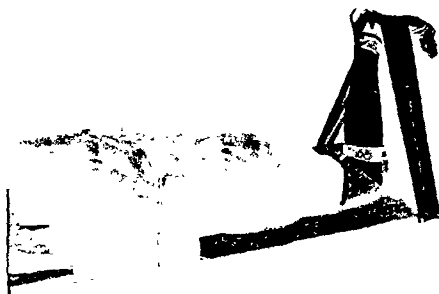


Fig. 65. Position (3) for application of the plaster boot.

12 inches above the surface of the table. Flexion or extension of the ankle is adjusted by moving the patient or the suspension rope.

(2) (Fig. 64.) The patient lies supine, with the knees 8 inches beyond the edge of the table. An ironing board or similar piece of wood is laid between the patient's body and the table, with the end extending to the popliteal space of the affected leg. The unaffected leg is suspended or placed on an adjoining table in extension and abduction. The surgeon sits on a stool before the affected leg which is flexed at 90° over the end of the board.

in place over the tibial crest. Two slabs are measured, an anterior and a posterior. The former extends from the base of the toes to the tibial tubercle. The latter begins one finger's breadth distal to the insertion of the biceps femoris, passes over the heel to the metatarsal-phalan-



Fig. 69. The completed boot. A platform for the toes has been fashioned instead of a "bumper."

geal joints and back upon itself to the level of the malleoli. Both slabs are made of 8 thicknesses of plaster bandage and carefully molded into place. Cuts are made on either side of the anterior slab at the upper instep to allow it to fit without wrinkles. The distal end

(3) (Fig. 65) The patient lies prone. The knee is flexed at 90° so that the leg projects vertically from the table. After the stockinette is fitted, it is fixed in position by a 3-inch muslin or flannel bandage carried across the instep in the weight-bearing line of the tibia and firmly fastened to the sides of the table.

PROCEDURE

The Application of Plaster

Padding, if used, is applied as follows, after fitting with stockinette and fixing in position: the long strip of felt is fitted around

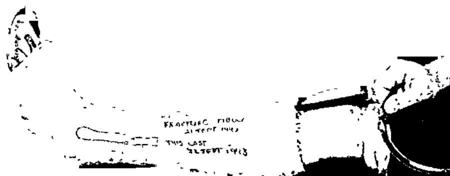


Fig. 68. The completed boot with "bumper." The greased rubber tube is being withdrawn.

the leg, with its anterior upper edge just proximal to the tibial tubercle and the posterior a finger's breadth distal to the level of the insertion of the biceps femoris. The edges of the felt squares are beveled, and the squares made into Maltese crosses by the excision of V's from each corner. These are fitted snugly over the malleoli and heel and held in place with adhesive tape. The greased rubber tube is laid



Fig. 70. Treads built up with sponge rubber and felt before application of plaster.

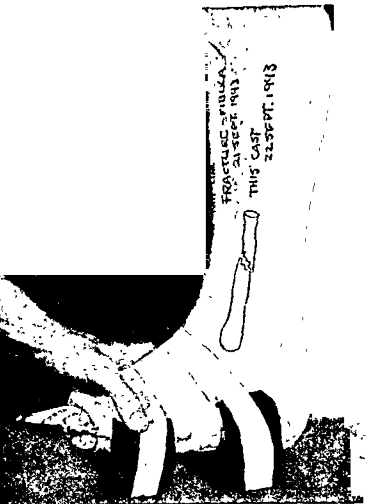


Fig. 71. Temporary trial adjustment of treads.

of the posterior slab is carefully turned back on itself at the plantar aspect of the metatarsal-phalangeal joints so that full flexion of the toes is possible (Fig. 66). If it is desired to prevent flexion of the toes, the slab is turned back on itself a finger's breadth beyond the great toe, forming a platform on the flexor surface. "Dog ears" in the posterior slab on either side of the heel are excised. The slabs are bound in place by three rolls of plaster bandage. If the posterior slab is carried beyond the metatarsal-phalangeal joints to provide a platform for the toes, it is trimmed with a scalpel, just before it sets, to a curve corresponding with the ends of the toes and a finger's breadth beyond them. If the toes are left free, the iron is bent to form an arch or "bumper" parallel to the ends of the toes and a finger's breadth beyond them. The sides of the arch are bent to fit the cast along the lateral and medial aspects of the foot and are held in place by circular turns of plaster bandage. Throughout the application of plaster, care is taken to mold the cast snugly against the longitudinal and transverse arches of the foot (Fig. 67). Finally, excess stockinette is trimmed away, its edges turned back and held with plaster bandage, and the greased rubber tube is withdrawn (Figs. 68 and 69).

The Fitting of Treads

The cast should be quite solid before treads are fitted. The sponge rubber or felt blocks are placed against the inner curves of the sections of tire. While the patient stands, one section of tire is placed over the heel, directly below the malleoli, and the other below the metatarsal heads, parallel to the first, and both are temporarily fastened in place with adhesive tape (Fig. 70). The patient then takes a few steps, and adjustments are made as indicated (Fig. 71). Particular attention must be paid to the height and position of the anterior tread. If it is too low, the "bumper," or extension of the posterior plaster slab, will strike the ground at each step and will soon break; if it is too high, the gait will be unnatural. At times, the nature of the injury for which the cast was applied requires immobilization of the ankle in flexion greater than the usual 90°. In this case, the posterior tread must be built up with care. When both treads are perfectly adjusted, and the patient walks with a normal

in molding over the malleoli and arches. If the injury is such that relaxation of the gastrocnemius and soleus muscles is necessary Position (2) is preferred, although the ankle is not fixed. This is often useful for the reduction of fractures of the shafts of the tibia and fibula. After the boot has been applied and has set, the lower leg



Fig. 73. Habitual eversion of foot, the result of walking device bearing the weight on a single point.

can be carefully elevated, the knee supported in a sling, and the cast extended to the groin (see page 81). Position (3) can be used instead of (1) when no suspension is available, but is more awkward and, since it tends to compress the angle against the leg, should never be used for any injury involving diastasis of the tibia and fibula.

heel-toe gait, the adhesive tape is replaced with a roll of plaster bandage. One or two turns are taken directly over the weight-bearing surfaces of the treads, but the remainder of the bandage is carried over the foot and in front and back of each tread in a "figure 8" fashion (Fig. 72).



Fig. 72. The completed boot with treads. Note that "bumper" does not strike the ground at the end of the stride.

REMARKS

The plaster boot immobilizes the foot and ankle. It is useless and even dangerous for injuries above the level of the malleoli. Position (1) is the most generally useful, since it allows the greatest freedom

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REMARKS

The plaster boot immobilizes the foot and ankle. It is useless and even dangerous for injuries above the level of the malleoli. Position (1) is the most generally useful, since it allows the greatest freedom

Five pieces of ½-inch felt:
- Three 3 x 3 inches
- One 3 x 13 inches
- One 3 x 22 inches

POSITION

The patient lies supine. Stockinette is fitted from the groin to 8 inches beyond the toes. A tongue depressor or similar piece of wood is fitted inside the stockinette just beyond the toes, and the end of the stockinette beyond is tied to an overhead rope. If it is desired



Fig. 74. Position for application of a full-leg cylinder in full extension.

to immobilize the knee in full extension, and if the injury is such that further support is not necessary, the foot is lifted about 18 inches from the table by the overhead rope, and the degree of flexion of the ankle adjusted by moving either the table or the rope (Fig. 74). If, as is usually the case, flexion of the knee is required, a sling is adjusted between two broomsticks or similar uprights, lashed to the sides of the table at the level of the pelvis. The lower leg is held parallel to

Padding, as a rule, does no harm but should be avoided, if possible, in all injuries requiring snug fitting of the cast, such as metatarsal fractures and injuries involving the widening of the tibiofibular joint. The anterior or extensor portion of the cast should lie exactly at the bases of the toes. If a portion of the dorsum of the foot is left exposed, edema is likely to occur. Trimming or partial splitting of the dorsum of the cast to relieve such edema is useless. Replacement of the entire boot is usually required.

The greatest care should be taken to mold and even exaggerate the normal contour of the transverse arch, particularly in patients with potential claw-toe deformity. This is particularly true in Position (1) in which the stockinette, as it suspends the leg, tends to reverse the normal curve of the transverse arch. As a general rule, *the toes are left free, protected by a "bumper," if the injury is above* the level of the metatarsal-cuboid joints, and a platform on the flexor surface is made, if below.

Any walking device or arrangement of treads is satisfactory if it fulfills the following requirements:

(1) It must permit normal heel-to-toe walking.

(2) It must not be too high, else the pelvis will be tilted at each step and painful back strain result. In middle-aged obese patients, lifts to the sole of the opposite shoe should be considered.

(3) It should be light and yet sturdy.

(4) It should be resilient.

The worst walking device carries the weight on a single point, such as a crutch tip. Patients who wear this for a few weeks often develop a habit of eversion of the foot at each step which is very difficult to break (Fig. 73).

THE FULL LEG CYLINDER

Materials Required

Eleven rolls of 6-inch plaster bandage
Thirty-two inches of 3-inch stockinette
Twenty-four inches of 6-inch stockinette
Fourteen inches of ¼-inch iron rod

the surface of the table and elevated until the desired degree of knee flexion is reached, when the sling is fitted over a felt pad behind the distal end of the femur (Fig. 75). When support of the lower leg is necessary, as in unstable fractures of the tibia and fibula, an 18-inch length of broomstick is suspended by a 36-inch piece of rope passed through drill holes at each end from the overhead traction rope. The broomstick is placed parallel to and 12 inches above the lower leg. To one end is attached the excess stockinette beyond the toes,



Fig. 75. Position for application of a full-leg cylinder with the knee in flexion.

and to the other a sling with pad and spreader passing behind the upper tibia and fibula. A second sling is placed at the point requiring greatest support (Fig. 76).

PROCEDURE

Stockinette, or, if necessary, sheet wadding, and padding are applied before fixation in position. The long strip of felt is snugly fastened around the thigh at the level of the ischial tuberosity and

of the arch are bent to fit the cast along the lateral and medial aspects of the foot and are held in place by the final turns of plaster bandage, which also anchors the turned-back stockinette (Fig. 79).

REMARKS

The full-leg cylinder immobilizes the foot, ankle, leg, and knee. It is worse than useless for injuries of the upper leg. Certain injuries, such as fractures of the patella, do not require immobilization of the foot, and the lower end of the cast can be carried to the malleoli.

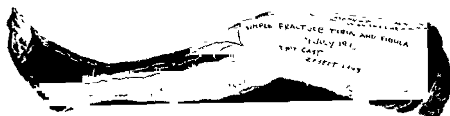


Fig. 79. The completed full-leg cylinder.

Certain fractures of the tibia and fibula may be difficult to manage by overhead suspension. For these, a leg cylinder can be constructed in sections, first applying a boot, with the leg flexed over the end of the table (Position (2), the Plaster Boot, page 68). When the boot has set, it is suspended above and parallel to the surface of the table, a sling is adjusted behind the knee, and the cast is built up to the groin with slabs and circular turns in the usual manner. With this plan, reduction and alignment of the fragments is assisted by gravity.

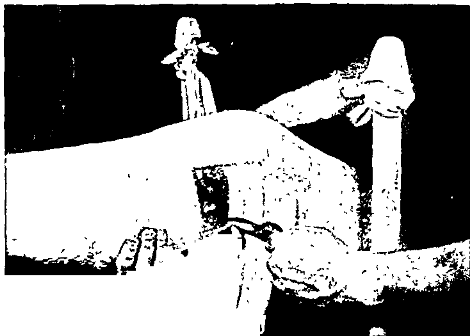


Fig. 77. Removal of sling and pad after slabs have set.



Fig. 78. Closing gap after removal of sling and pad.

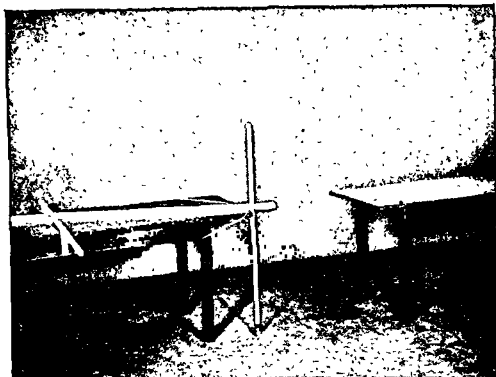


Fig. 80. Tables, board, and broomsticks arranged for application of a single hip spica.

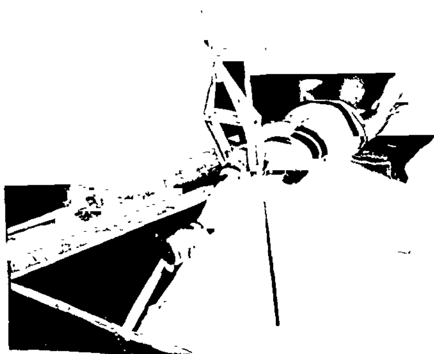


Fig. 81. Patient in position for application of the single hip spica. Padding is in place.

THE HIP SPICA

Materials Required

For the single spica:

- 25 rolls of 6-inch plaster bandage
- 20 inches of 9-inch stockinette
- 16 inches of 6-inch stockinette
- 18 inches of 3-inch stockinette
- 6 pieces of felt:
  - One 6 x 12 inches
  - One 3 x 36 inches
  - Two 3 x 10 inches
  - Two 4 x 8 inches

For the double spica:

- 35 rolls of 6-inch plaster bandage
- 20 inches of 9-inch stockinette
- 32 inches of 6-inch stockinette
- 36 inches of 3-inch stockinette
- 8 pieces of felt:
  - One 6 x 12 inches
  - One 3 x 36 inches
  - Four 3 x 10 inches
  - Two 4 x 8 inches
- One 3-foot length of broomstick

Position

Position (1) is suitable only for the single spica. Position (2) can be used for either the single or double spica.

(1) (Fig. 80.) A broomstick or similar piece of wood or pipe is lashed upright at the corner of a table. A board approximately 60 x 4 x ½ inches is laid flat on the table against the broomstick, projecting about 6 inches beyond the edge, with its other end near the diagonally opposite corner. A second broomstick is lashed across the table top and board, parallel to, and about four or five feet from, the end over which the board projects. Its end extends outward from the same side of the table to which the vertical broomstick is lashed. A

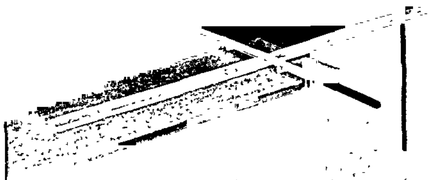


Fig. 82. Tables, broomsticks, and boards arranged for application of single or double hip spica.

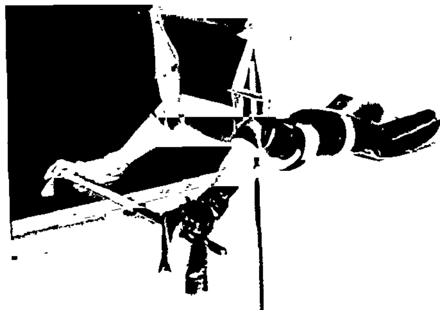


Fig. 83. Patient in position for application of double hip spica.

second table of the same height is placed about two feet from the first, with the center of its end opposite the vertical broomstick. The patient lies supine, with the perineum against the vertical broomstick, the sacrum on the projecting board, the uninjured leg on the first table, and the thorax on the second. A Collins or other hitch is taken around each ankle with flannel bandage, the ends of which are firmly lashed to the horizontal broomstick. Flexion at the knee is controlled by overhead traction on a flannel bandage loop with pad and spreader from the popliteal space. Abduction is adjusted by shifting the ends of the bandage on the broomstick. Traction on the feet and knee is adjusted until the thorax, buttocks, and heel lie in the same plane (Fig. 81).

(2) (Fig. 82.) A 1½-inch hole is drilled 6 inches from the end of a 60 x 4 x ½-inch board, which is laid on the surface of a narrow table, projecting 3 feet from the middle of its end. A broomstick is passed through the hole to the floor and anchored with a nail driven through its shaft below the board. Two other broomsticks or similar pieces of wood or pipe are lashed to each other and to the board and the surface of the table about 18 inches from, and parallel to, its end, so that each projects about 3 feet. A second table is placed about 2 feet from the vertical broomstick. The patient lies supine, with the sacrum on the end of the projecting board, the perineum against the vertical broomstick and the thorax on the second table. The ankles are fastened to the horizontal broomsticks with Collins or other hitches. The knees are flexed, if desired, by overhead traction on flannel bandage slings, with pads and spreaders (Fig. 83). Care is taken to keep the thorax, buttocks, and heels in the same plane.

Procedure

Stockinette is fitted and padding applied before fixing in position. The largest size stockinette covers the trunk, the medium the thigh, and the 3-inch the lower leg. The largest piece of felt is sewed or taped over the sacrum and the spinous processes, the long strip around the thorax two fingers' breadth below the nipples, the two 4 x 8-inch pieces over the iliac crest, one 10-inch strip just above the malleoli, and the other on the inner aspect of the groin against the ischial tuberosity. The greased rubber tube is laid in place along the

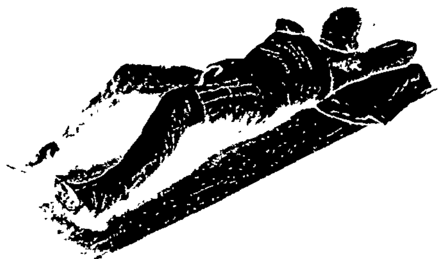


Fig. 85. The completed single hip spica.

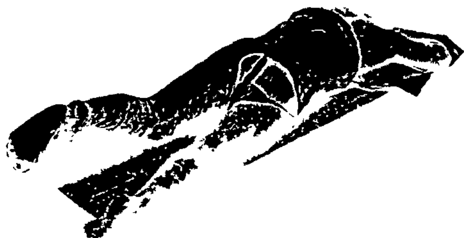


Fig. 86. The completed single hip spica, posterior view.

crest of the tibia, the anterior aspect of the thigh, and the nipple line. The following slabs are measured:

(1) *Anterior*, from the malleoli to the middle of the strip of felt around the thorax just above the xiphoid.

(2) *Posterior*, from the malleoli over the buttock to a point opposite the end of slab (1).

(3) *Lateral*, from the malleoli to the upper level of slabs (1) and (2) below the axilla.

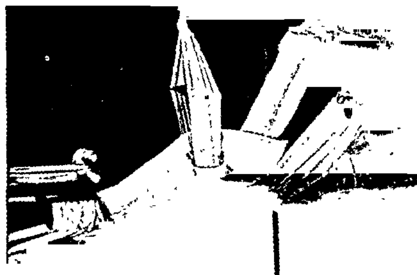


Fig. 84. The single hip spica; slabs (1), (2), and (3) are in place. Slab (4) is being applied.

(4) *Spica*, from the umbilicus across the iliac crest and the upper femur around the thigh, along the groin, crossing itself at the upper femur and around to the low mid-back.

(5) *Circular*, around the trunk at the level of the symphysis pubis.

(6) *Circular*, around the trunk at the level of the upper ends of slabs (1), (2), and (3).

All slabs are made of 8 thicknesses of plaster bandage, are laid in place in the order listed and held with circular turns, which are begun as soon as the first two slabs are applied (Fig. 84).

and the two extremities are united with a 3-foot broomstick or board. This is laid across the anterior surface of the thighs, after the plaster has set, at approximately the center of gravity of the cast and anchored firmly in place with "figure 8" turns of plaster bandage (Figs. 87 and 88).



Fig. 88. The double hip spica, posterior view.

REMARKS

The single hip spica immobilizes the hip, femur, and knee, and the double spica the pelvis as well. It is not always necessary to include the foot, if the knee is sufficiently flexed to prevent rotation.

The completed cast should be 6 to 8 layers in thickness, except where reinforced by slabs. Slab (4) should be applied with great care, fitting snugly against the felt pad overlying the ischial tuberosity. Slab (5) and the spica turns of plaster bandage anchoring it should be fitted to permit use of the bedpan without soiling and, at



Fig. 87. The double hip spica, anterior view.

the same time, should support the buttock. An aperture or arc of 3-inch radius with the anus as the center is usually satisfactory (Figs. 85 and 86). Excess stockinette is trimmed away, the edges turned back and held with the final layer of plaster bandage.

For the double spica, slabs (1), (2), (3), and (4) are duplicated,

Boards should be placed between the mattress and the springs of the patient's bed, and a "trapeze" suspended from above at the level of the shoulders. Weak and aged patients should, in addition, have the weight of the cast lightened by counterweights attached through pulleys to slings around the waist and knee, or, in the case of the double spica, from the transverse broomstick (Fig. 89).

The increased circulation to the limb, produced by motion of t foot and ankle, is often very desirable, but care must be taken prevent the formation of pressure sores on the anterior and poste aspects of the lower leg at the end of the cast. If the foot is to included, it can be done after the body of the cast has set, and tl traction hitch on the ankle has been removed. Short anterior posterior slabs are applied, with a "bumper" as in the Plaster Bc If circumstances demand that the foot or feet be included in the



Fig. 89. A sling with counterweights arranged about the waist of a hip spica to facilitate nursing.

before removal of the traction hitch, and the traction hitch is tied over it knots and wrinkles. Slabs (1) and (2) are made long enough to f a boot.

Particular care should be taken to mold slab (4) and the turns of plaster bandage snugly against the felt pad over the isch tuberosity. This medial aspect of the thigh portion of the cast like the padded ring in the Thomas splint and prevents overridi or shortening of fracture of the femur.

re fixed to each other with safety pins at the point of crossing pposite the ear. Twelve-inch spreaders are placed in both slings nd held in place with thumb tacks. The patient must sit upright, ven slightly extended beyond the vertical.

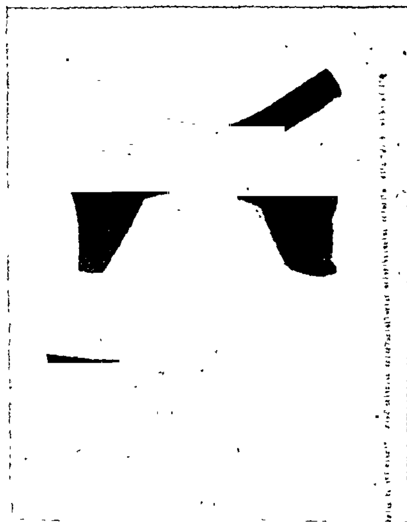


Fig. 90. Pattern for full padding for plaster jacket immobilizing cervical spine.

ROCEDURE

The felt padding, which has previously been cut to pattern (Fig. o) and fitted on a subject of approximately the same size and weight s the patient, is sewed in place on the stockinette. The iron rod is ent to fit the curves of the back and the neck and to fit exactly the

CHAPTER IV

THE VERTEBRAL COLUMN

PLASTER JACKET FOR IMMOBILIZATION OF THE CERVICAL SPINE

MATERIALS REQUIRED

Fifteen rolls of 6-inch plaster bandage
Twenty-six inches of 9-inch stockinette
Fourteen inches of 6-inch stockinette
Felt cut to the pattern illustrated in Fig. 90
Forty inches of ¼-inch iron rod

POSITION

The occiput should be closely clipped, and the rest of the l
cut quite short.

Before the patient is moved from bed, a "bathing suit" is m
from the 9-inch stockinette by sewing in the crotch and over
shoulders. The 6-inch stockinette is slipped over the head and ca
fully sewed to the body piece, avoiding folds or creases. A small h
is cut for the nose. If skeletal traction has been employed this is n
disengaged from the traction weights. Traction and hyperextensi
are maintained manually by the surgeon while assistants slowly a
carefully seat the patient on a stool (Fig. 91). The skeletal tracti
is then attached to an overhead rope. If skeletal traction has not be
used, two slings of 3-inch muslin or linen bandage are arranged fro
overhead ropes and adjusted on a subject of approximately the sa
size and weight as the patient. One of the slings passes beneath t
chin and backward across the ears (Figs. 92, 93, and 94). The oth
supports the occiput and crosses the first at approximately 90°. A
the patient is lifted from bed, and the slings are fitted in place, th
surgeon maintains the position of the neck, with his palms supportin
the occiput and his fingers the mandible (Fig. 91). The two sling



Fig. 93. Another view showing padding and slings in place.



Fig. 94. Posterior view, with padding and slings in place.



Fig. 91. Position of the neck being maintained manually by the surgeon while patient is transferred from bed to stool.



Fig. 92. Padding and supporting slings are in place.



Fig. 95. Slabs (1) and (2), and the reinforcing iron rod in place.

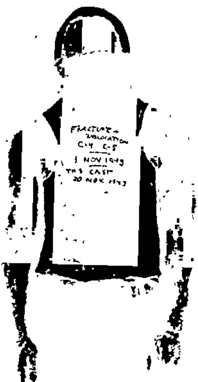


Fig. 96. The completed plaster jacket for immobition of the cervical spine, anterior view.

middle of the felt strip around the forehead. The following slabs measured;

(1) From the nipple to the occiput, around the head, and to the other nipple.

(2) From the occipult to the twelfth dorsal vertebra.

(3) Around the neck.

(4) Around the trunk at the level of the iliac crests.

Six-inch bandage is used for all slabs. Slab (1) is made 6 layers thickness; all the others are 8. Slab (1) is laid in place by pl its middle against the center of the forehead, and is trimmed w scissors to the exact width of the felt padding as it passes around th head. Slab (2) is then laid in place and held with a few circular The iron rod is placed against it and the head portion of slab (1) (Fig. 95). A second slab (1) is made and fitted over the rod down the back, instead of over the shoulders, to the anterior thorax The head portion is trimmed in the same manner as the first slab (1). Slab (3) is placed around the neck and snugly against the mandible and beneath the mastoid process, about a finger's breadth from the point of the chin. Care is taken with this slab to leave an ample margin of felt padding between the plaster and the mandible and mastoid process. Circular turns of plaster unite the slabs. "Spica" and "figure 8" turns are taken around the neck and shoulders. Slab (4) is incorporated in the circular turns and is arched upward over the abdomen and back. The completed cast should be 6 to 8 layers in thickness, except where reinforced by slabs. Excess stockinette is trimmed away and the edges turned back and held with a final layer of plaster bandage. When the plaster has set, the slings are cut and slipped out (Figs. 96, 97, and 98).

REMARKS

The cervical plaster jacket is used most frequently for fractur and dislocation of the cervical vertebrae. It is, at best, uncomfortabl and trying for the patient. The greatest care must be exercised to avoid painful points of pressure, especially along the mandible and behind the ears. At the same time, motion of the mandible must be almost completely eliminated to prevent flexion movements in the cervical spine. The forehead band prevents rotation but does not, in

itself, limit flexion. Many patients will experience difficulty in swallowing, until a window is cut over the anterior aspect of the neck. If skeletal traction has been used prior to application of the cast, it is advisable to leave it in place until check films have demonstrated the fracture or dislocation to be in good position, and until the cast has proved to be snug and reasonably comfortable.

The application of a cervical plaster jacket to a patient in the supine position is a very difficult procedure. Methods are described for the manipulative reduction of fractures and dislocations of the cervical spine under general anesthesia, followed immediately by immobilization in plaster. However, the great majority of fractures and dislocations of the cervical spine can be safely reduced by traction and later fixed in plaster at the surgeon's convenience and with the patient's cooperation.

PLASTER JACKET FOR IMMOBILIZATION OF THE DORSAL AND LUMBAR SPINE

Materials Required

Twenty-five rolls of 6-inch plaster bandage
Thirty-six inches of 9-inch stockinette
Five pieces of felt:
- One 4 x 18 inches
- Two 4 x 6 inches
- Two 4 x 8 inches

Position

The patient lies prone between two tables, one about 10 inches higher than the other. Both tables are well padded with blankets, which extend over the edge and are anchored to prevent slipping. The patient supports himself between his forearms held transversely across the face on the higher table and his legs below the mid-thighs on the lower. The edges of the tables should never be closer to the middle of the body than the middle of the neck and middle of the thigh (Fig. 99).



Fig. 97. The completed plaster jacket for immobilizing the cervical spine, side view.



Fig. 98. The completed plaster jacket for immobilizing the cervical spine, posterior view.

are rapidly made, laid in place and held with circular turns of plaster bandage. Two each of slabs (3) and (4) are made and incorporated with circular turns into each side of the cast. No circular turns are taken over the shoulders. An assistant maintains firm steady pressure against the upper sternum and symphysis pubis until the plaster has set. The plaster is thoroughly rubbed as it is applied (Fig. 100). The completed cast should be 6 layers in thickness, except where re-



Fig. 100. All of the slabs have been laid in place and the last turns of circular bandage are being taken.

inforced by slabs. When the plaster is quite firm, usually not less than 15 minutes after the application of the last bandage, the patient is carefully placed supine on a firm bed, with pillows supporting the hyperextended back. Trimming in axillae, groin, and back is carried out during the next two or three days as indicated. Most patients are more comfortable with an 8-inch aperture over the abdomen. When all trimming is complete, and the patient can sit, walk, and lie comfortably, the stockinette edges are turned back and held with a final layer of plaster bandage (Figs. 101, 102, 103).

Procedure

Padding is done before the patient is placed in position. A "bathing suit" is made of the stockinette by passing it over the trunk and stitching it over each shoulder and between the legs. The long strip of felt is fastened by tape or sewing over the spinous processes from the sacro-coccygeal joint to the fifth dorsal vertebra. The two 4 x 6 pieces are fastened over the upper end of the sternum and the pubic



Fig. 99. Position of hyperextension for plaster jacket immobilizing the lumbar and lower dorsal vertebrae.

symphysis. The 4 x 8 pieces are fitted over the iliac crests. The following slabs are measured:

(1) From the supra-sternal notch to a finger's breadth distal to the symphysis pubis.

(2) From the sacro-coccygeal joint to the fifth dorsal vertebra.

(3) From the supra-sternal notch around to the sacro-coccygeal joint.

(4) From the symphysis pubis around to the fifth dorsal vertebra.

All slabs are made of 8 thicknesses of plaster bandage. As soon as the position of the patient is satisfactory, slabs (1) and (2)

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(4) From the symphysis pubis around to the fifth dorsal vertebra.

All slabs are made of 8 thicknesses of plaster bandage. As soon as the position of the patient is satisfactory, slabs (1) and (2)

REMARKS

The plaster jacket is used primarily for fracture of the bodies of the lumbar and lower dorsal vertebrae. Immobilization is quite satisfactory, and the position as described usually effects reduction of fresh crush or wedge fractures. Other measures may be required

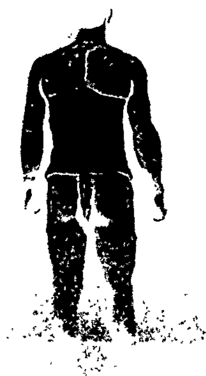


Fig. 103. The completed jacket, posterior view.

to reduce fractures of the upper dorsal vertebrae, but, once reduced, they are held fairly well.

No plaster cast requires greater teamwork in application. At least three assistants are required—one to sit at the patient's head and help maintain his position, one to hold the upper and lower ends

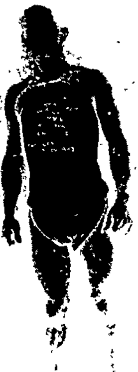


Fig. 101. The completed jacket, anterior view.



Fig. 102. The completed jacket, side view.

INDEX

of the cast firmly against the sternum and symphysis pubis, and one to make slabs. If general anesthesia is used, a fourth assistant will be required to hold the patient's legs in place. All assistants should thoroughly understand their duties, and a rehearsal, with the surgeon acting as patient, of all steps involved, from the lifting of the patient from bed to the actual application of plaster, is often advisable. If, as is generally the case, a general anesthetic is not used, the patient should understand what is required of him, and the position should be demonstrated to him by the surgeon or an assistant. The position, at best, is trying, and speed in application of the cast is essential. No more than 10 minutes should be required, and the patient should be returned to his bed in at least 25 minutes.

Maintenance of hyperextension and immobilization of the fracture depend on snug fitting of the cast at three points: the fracture site, the symphysis pubis, and the upper sternum. The assistant who holds the plaster against the sternum and symphysis has, therefore, a very important job. The pressure which he exerts with his hands must be steady and uninterrupted. When he becomes tired, he should be relieved by the assistant at the patient's head.

INDEX

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INDEX